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VOLUME IB



SELF-TENSIONING ACOUSTICAL
HORIZONTAL LINE ARRAY
(SPRAY)
DATA ANALYSIS (U)

V. 1A 00 10 13

FINAL REPORT OF BEARING STAKE TESTS
JANUARY THRU MARCH 1977

JANUARY 1979

LEVEL III

Prepared For
NAVAL AIR DEVELOPMENT CENTER
WARMINSTER, PENNSYLVANIA

UNDER CONTRACTS
N62269-77-C-0139
AND
N62269-78-M-6884
BY

SANDERS ASSOCIATES, INC.
95 CANAL STREET
NASHUA, NEW HAMPSHIRE 03061

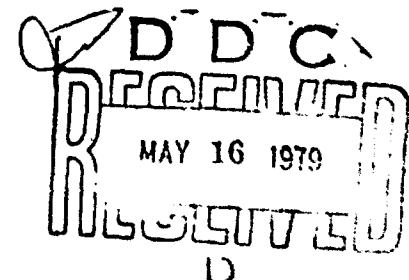
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VOLUME IB

SELF-TENSIONING ACOUSTICAL
HORIZONTAL LINE ARRAY
(SPRAY)
DATA ANALYSIS. (S)

LEVEL

FINAL REPORT OF BEARING STAKE TESTS
JANUARY THRU MARCH 1977,

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VOLUME

IA	Overall Program Status and Test Results Summary
IB	Detailed Description, Test Results
II	Data Analysis Facility and Data Reduction Methodology
IIIA	Data Points 1, 2 and 3 Raw Data
IIIB	Data Points 4, 5 and 6 Raw Data
IVA	Data Points 7, 8 and 9 Raw Data
IVB	Data Points 10, 11 and 12 Raw Data

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2.0 DETAILED DISCUSSION OF TEST RESULTS (U)

(U) The contents of this Volume discuss in more detail the measured vs expected results for each of the following:

- System FOM
- Array Gain and Signal Gain
- Beamwidth
- Bearing Accuracy
- Summary and Comparisons

2.1 SYSTEM FIGURE OF MERIT AND RANGE PREDICTIONS (U)

(U) System figure of merit (FOM) is defined as the total signal transmission loss that the system can tolerate and is expressed as

$$\text{FOM} = \text{SL} - \text{NL} + \text{AG} - \text{DT} \text{ (dB)} \quad (2.1)$$

where

SL = threat source level (dBuPA)

NL = local ambient noise spectral level (dBuPA²/Hz)

AG = array gain (dB)

DT = detection threshold

(S) For the third generation threat, the detection threshold was computed for the 140 and 290 Hz lines as shown in Table 2-1 for a 1/32nd analysis bandwidth (ABW). It is noted that in addition to a 1.3 dB mismatch loss, a processing loss of 2 dB was used to cover all other real processor degradations from ideal. A 5 minute integration time was assumed.

(S) Detection ranges for the third generation Soviet Nuclear Threat are estimated from the FACT-model-computed transmission loss (Volume IA, Figures 1-10, 1-11, 1-13, 1-14, 1-16, 1-17) based on FOM's computed from the measured data per equation (2.1).

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TABLE 2-1

DETECTION THRESHOLD CALCULATION FOR 3RD GEN THREAT,
1/328 ANALYSIS BANDWIDTH (U)

Frequency (Hz)	Signal Line Width (Hz)	ABW (Hz)	N_s	DT Ideal (dB)	$-L_M$ (dB)	Processing Loss (dB)	Total DT Degradation (dB)	DT Actual (dB)
140	0.044	0.044	13	-12.2	1.3	2.0	3.3	-8.9
290	0.10	0.091	27	-11.0	1.4	2.0	3.4	-7.6

$DT_{ideal} = SNR(N_s) + 10 \log ABW = \text{Signal-to-noise in one Hz band required at processor input}$

$SNR(N_s) = \frac{1}{N_s}$ Signal-to-noise required at the linear detector input
for $P_D = 0.5$, $P_{FA} = 10^{-4}$, $T = 300$ sec integration time

$N_s =$ Number of independent samples integrated

$L_M = 10 \log (1 - \beta/4)$ (dB) $0 \leq \beta \leq 2$ mismatch loss

$\beta = \frac{\text{Signal Line Width}}{ABW}$

$DT_{actual} = DT_I - L_M + \text{Proc Loss}$ (dB)

ABW = Analysis bandwidth of narrowband filter preceding detector

- (1) Obtain from Robertson's curves, G. H. Robertson, "Operating Characteristics for a Linear Detector of CW Signals in Narrowband Gaussian Noise", Bell Sys. Tech. J., April 1967.

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(S) Table 2-2 contains the FOM and estimated range data for each data point in the three sites. Range zones (convergence zones) for greater than 50% detection probability are listed as well as the maximum 50% P_D range, which is averaged over the data points for each site (averages shown in last column). Data for 140 Hz as well as 290 Hz is provided. Note, however, that for a nominal $\lambda/2$ spacing, one would expect a nominal 3 dB gain improvement for the 140 Hz data, and thus expect range increases by approximately 1.5 to 2.0 times.

(S) The mean FOM for the 12 data points at 290 Hz is 89.8 dB; the greatest value is 92.9 for DP 9 in Site 4, and this corresponds to a continuous (no convergence zones) detection region out to 203 NM. Detection regions covered in the three sites are pictured in Volume IB, Figure 1-3, for the above conditions.

2.2 ARRAY GAIN AND SIGNAL GAIN (U)

(U) Measured array gain (SNR Gain) and signal gain are compared against theoretical reference curves vs number of elements in the aperture for all 12 data points in Figures 2-1 and 2-2. For comparison, the corresponding composite data for the deep MINYAKA site is contained in Figure 2-3. Individual data point presentation of gain data appear as Figures A-1 through A-24 in Appendix A.

(S) Measured signal gain clusters around the theoretical curve ($20 \log N$) except for the Gulf of Oman (DP 1 and 2, Figure 2-1). This site might be expected to show somewhat poorer signal gain due to the large depth deficiency (see Section 1.2), and thus larger expected signal decorrelation resulting from greater signal acoustic interaction with the bottom and the surface. It is noted that the 140 Hz signal gain values (Figure 2-2) tend to be larger than the 290 Hz values. This also is expected since the aperture contains fewer wavelengths at 140 Hz and signal will, therefore, tend to be more correlated.

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(S) Table 2-2 FOM and Range Predictions Based on Measured Data. 3rd Gen Threat Line Levels and Line Widths: 290 Hz 135 dbuPa 0.091 Hz 140 Hz 135 dbuPa 0.044 Hz

Source Depth 60' Receiver Depth 100' FOMC Bottom Type 1

Site DP (dbuPa ² /Hz)	AG	FOM	1	2	3	4	5	Max R Range (FM)	P ₅₀ (2)
290 Hz DATA									
1A 1 65.7	10.0	86.9	0-45.9	55.8	25.7	96-97		85.7	98.3
2 64.7	11.1	89.1	0-50.2	54.8	71.2			110.8	
3 67.5	16.8	91.9	0-180					180.0	
4 65.6	9.8	86.8	0-27.6	44.2	47.4	55.7	24.8	83.7	
5 68.4	11.7	85.9	0-27.2	42.8	46.8	55.3	26.5	80.5	102.1
6 68.9	12.6	86.3	0-27.4	43.9	47.7	55.3	25.4	82.3	
7 62.2	7.1	87.5	0-27.7	43.6	47.4			84.0	
8 61.6	10.3	91.9	0-175					175.0	
9 65.2	15.5	92.9	0-203					203.0	
10 64.6	12.6	90.6	0-138					138.0	
11 62.2	12.1	92.5	0-194					194.0	150.7
12 65.5	6.7	83.8	0-27.6	49.6				43.6	
140 Hz DATA									
1A 1 140 Hz Not Predicted									
2 74.5	15.5	84.9	0-43.9	54.7	53.1			73.3	
3 73.3	9.3	79.9	0-35.9					35.9	
4 76.6	14.9	82.2	0-38.1	48.6				53.6	54.2
5 76.0	14.8	82.7	0-38.1	47.7				54.4	
6 70.1	8.5	82.3	0-38.2	48.5				53.8	
7 67.3	11.4	88.0	0-108					108.0	
8 68.2	13.2	88.9	0-129					129.0	
9 74.2	10.5	80.2	0-22.3					22.5	60.8
10 70.2	7.2	80.9	0-22.3					22.8	
11 72.0	6.8	78.7	0-21.3					21.5	

(1) P₅₀ = Range in M for 50% P

(2) P₅₀ = Mean P₅₀ for Site

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FIGURE 2-

64513

COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS
MEASURED AT
280 MHz (U)

SIGNAL GAIN

20 LDB N

100 DB/OCTAVE REFERENCE

- 1 - 1000 FT DATA
- 2 - 1500 FT DATA
- 3 - 2000 FT DATA

100 DB/OCTAVE REFERENCE

G 150

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NUMBER OF ELEMENTS

100

90

80

70

60

50

40

30

20

10

0

0

0

0

0

0

0

0

0

0

0

0

0

0

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FIGURE 1-2

COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS
MEASURED AT
140 HZ (24)

SIGNAL GAIN

140 HZ REFERENCE

1400 FM DATA
2800 FM DATA

ARRAY GAIN REFERENCE

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NUMBER OF ELEMENTS

100 90 80 70 60 50 40 30 20 10 0

100 90 80 70 60 50 40 30 20 10 0

100 90 80 70 60 50 40 30 20 10 0

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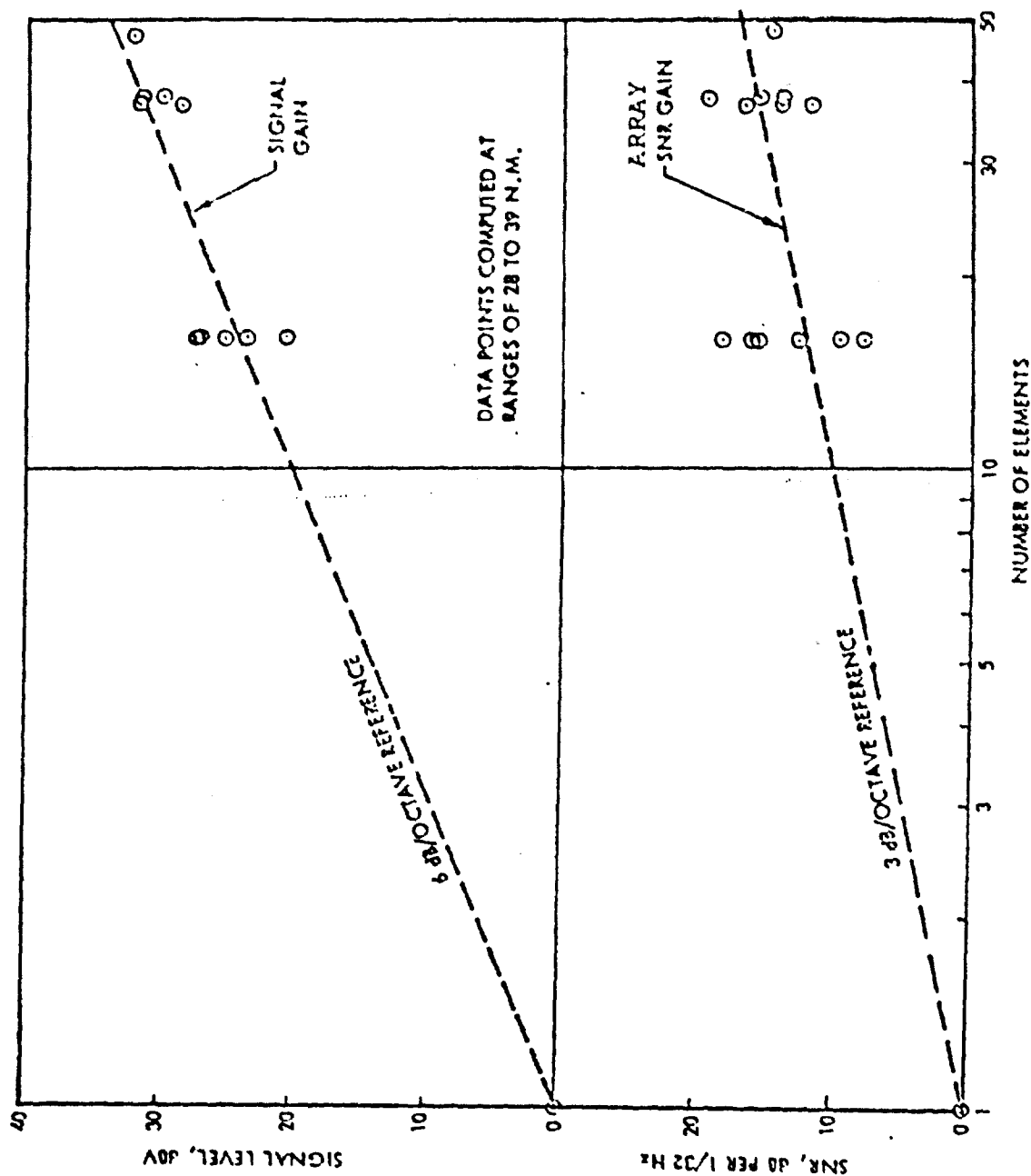


Figure 2-3 MIHAYAKA Data - Comparison of Signal Gain in Relation to SNR Gain vs. Number of Elements Measured at 295 Hz (U)

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(S) Also apparent is a characteristic droop in signal gain between half (32 elements) and full aperture, which becomes more significant at 290 Hz. The indication is that the plane-wavefront model used to process the data is becoming inadequate between 16 and 25 wavelengths, at least for the subject environmental conditions. Of course, uncompensated array deformation could also be at least partially at fault, but the progressively improved signal gain with improving acoustic conditions (going from Site 1A to Site 4) places greater credibility in the decorrelation argument. This indicates a need for more sophisticated array processing, especially in "shallow" water, for apertures approaching 25 wavelengths.

(C) The array (signal to noise) gain correlates reasonably well with signal gain according to the above referenced set of figures. One exception is site 1A where the signal gain is much farther below theoretical than array gain. Given the fact that array gain depends not only on coherently summing the signal, but also on rejecting noise ($\text{array gain (AG)} = \text{signal gain (GS)} - \text{noise gain (GN)}$), a lack of close correlation in array gain with signal gain is plausible. However, there appears to be an anomaly in the large discrepancy between signal gain and array gain for the Gulf of Oman. Noise anisotropy information is not contained in this report, but would be useful in relating signal gain and array gain.

(S) Of particular interest is the relatively constant level of measured array gain, independent of aperture (number of elements), unlike the deep water MINYAKA tests. This is especially evident for 290 Hz is given in Table 2-3 supporting this observation. Therefore, a strong indication is that in order to achieve the full potential of drift arrays in depth deficient water, the beamforming must accommodate a more complex model than a plane wave arrival; that is, it must include techniques to compensate for correlation losses.

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Table 2-3 Array Gain Comparison for 290 Hz
vs. Number of Elements (C)

Mean Array Gain (dB) for Number of Elements Shown, 290 Hz			
Site	16	32	max
1A	9.7	11.2	10.6
3	12.7	13.4	12.7
4	11.4	12.4	12.4
Overall Mean	11.8	12.7	12.3

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2.3 BEAMWIDTH (U)

(C) Theoretical beam patterns for each frequency and aperture analyzed at each data point (which have random steer angles) were computed for comparison with MRA pattern response measurements. A typical pattern for the uniform-weighted* full aperture is shown in Figure 2-4 for DP 10 at 290 Hz. The rectangular pattern plot covers the full azimuth plane, and references azimuth angle from end fire, i.e., broadside on these plots appears at 90° and 270° . Thus the 151.5° horizontal steering corresponds to 61.5° off-broadside steering in the context of the present report. Also provided in the hard copy computer display are the 3 dB beamwidth (4.12°) and array azimuth gain (15.0 dB). All other such plots generated are contained in Appendix B for reference. A brief discussion of the effect on theoretical beam pattern of elements missing from the aperture and quantizing lobes created by sampling data at a rate lower than that required for quantizing lobe suppression was given in Volume IA.

(U) Direct measurement of beamwidth in the normal sense during a sea test is not practical. Instead (of either rotating the array or maneuvering the projector ship on a circumferential course), an estimate of the beam characteristics is obtained by steering the beam over a relatively small azimuth region centered in the target direction. The estimate is good only in the main beam region; it is clear that the greater the beam is steered away from the target direction, the greater is the pattern error.

* Uniform weighting was used in beamforming for the entire data reduction. No sidelobe suppression was attempted.

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S106B SAMPER'S BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 QNTLRF 3.1
... 1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
... 200.0 HZ. 49 ELEMENTS, -0.87 DB MAX., AC:S1362,SU:S1362,WT:
... 30.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
... 4.12 DEG. 3 DB BEAM, 15.00 DB AZ. GAIN, MAX. AT 208.5 DEG. HORIZ.

DP10

UNIFORM WEIGHTING.

1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

200.0 HZ. 49 ELEMENTS, -0.87 DB MAX., AC:S1362,SU:S1362,WT:

30.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

4.12 DEG. 3 DB BEAM, 15.00 DB AZ. GAIN, MAX. AT 208.5 DEG. HORIZ.

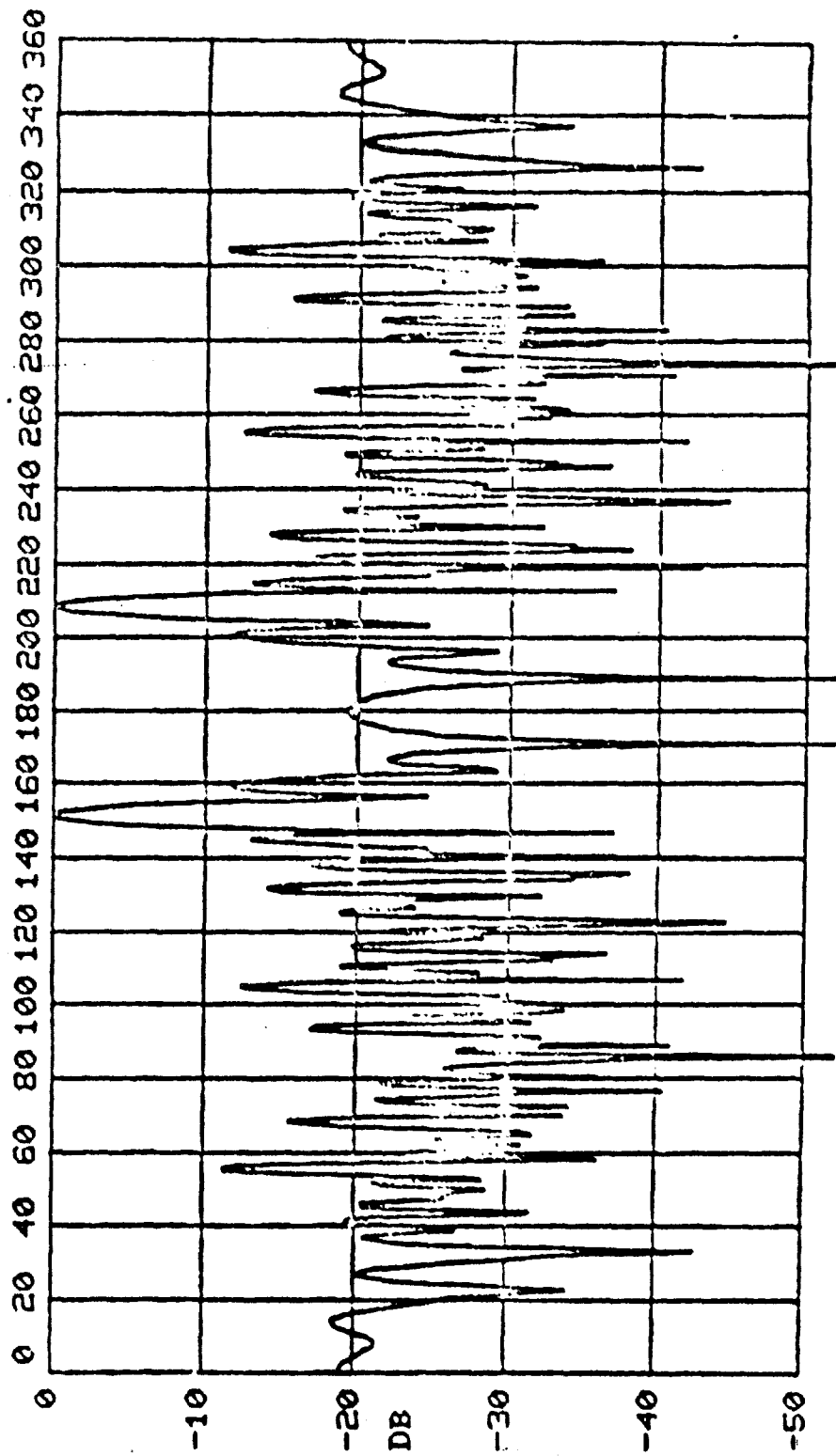


Figure 2-4 Theoretical Horizontal Plane Pattern for 49-Element Array @ 290 Hz
for Data Point 10, 61.5° off Broadside Steering. Beamwidth 4.12°,
Azimuth Gain 15.0 dB.

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(S) It is with this in mind that the "measured" pattern data should be viewed. Such a pattern appears in Figure 2-5 for DP 10 at 290 Hz, corresponding to the theoretical pattern of Figure 2-4. It represents one of the better examples of measured beam patterns, and is only 0.6° broader than theoretical. This corresponds to an array gain only 0.6 dB ($10 \log (4.1^\circ/4.7^\circ) = 0.6 \text{ dB}$) below theoretical. Unfortunately, the measured array gain suffered an actual degradation of 2.4 dB for this data point when the data was properly reduced.

(C) It is also noted that the presence of interfering sources, particularly in the vicinity of the main beam (or its image), has a degrading effect on the measured pattern quality, as well as on both signal and array gain. Either discrete tonals radiated within an analysis bandwidth of the projector tone, or broadband noise radiated from such interference contaminates the data. Figure 2-6 is an example of a measured pattern at 290 Hz for full aperture in DP 7 where interference plays a significant, or probably a dominant role. The target (projector) was received on a beam steered to -22° (where the MRA occurs in the figure). However, at least 3 other smaller pattern peaks occur within 12° . It is felt these are associated with interfering sources in the near vicinity of the array emplacement.

(C) If one considers the 140 Hz data for this same data point (see Figure 2-7), the MRA has apparently shifted to -36° steering, indicating a possible array orientation change. But this is not possible because the same 5 minute segment of tape was analyzed for both 140 Hz and 290 Hz. The presence of at least one other source can, therefore, be deduced from this data comparison. The interfering source at -36° steering has a greater received energy at 140 Hz than is received from the projector.

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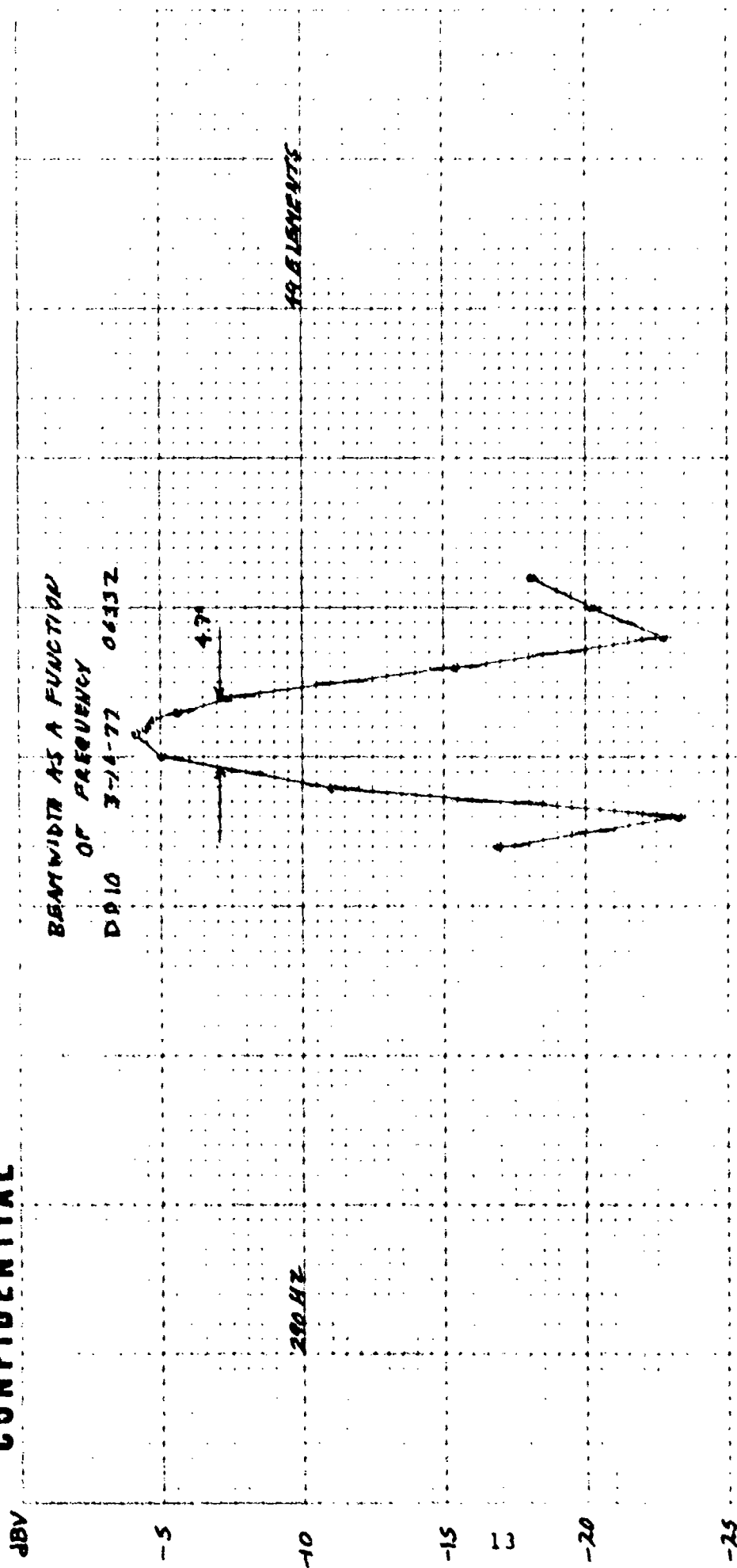


FIGURE 2-5 MEASURED Main Lobe Pattern Response for 49-Element Array @ 290 Hz for Data Point 10, is within 0.6° of Theoretical. Reference Figure 2-4

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+40 +50 +60 +70 +80
DEGREES OFF BROADSIDE

460103

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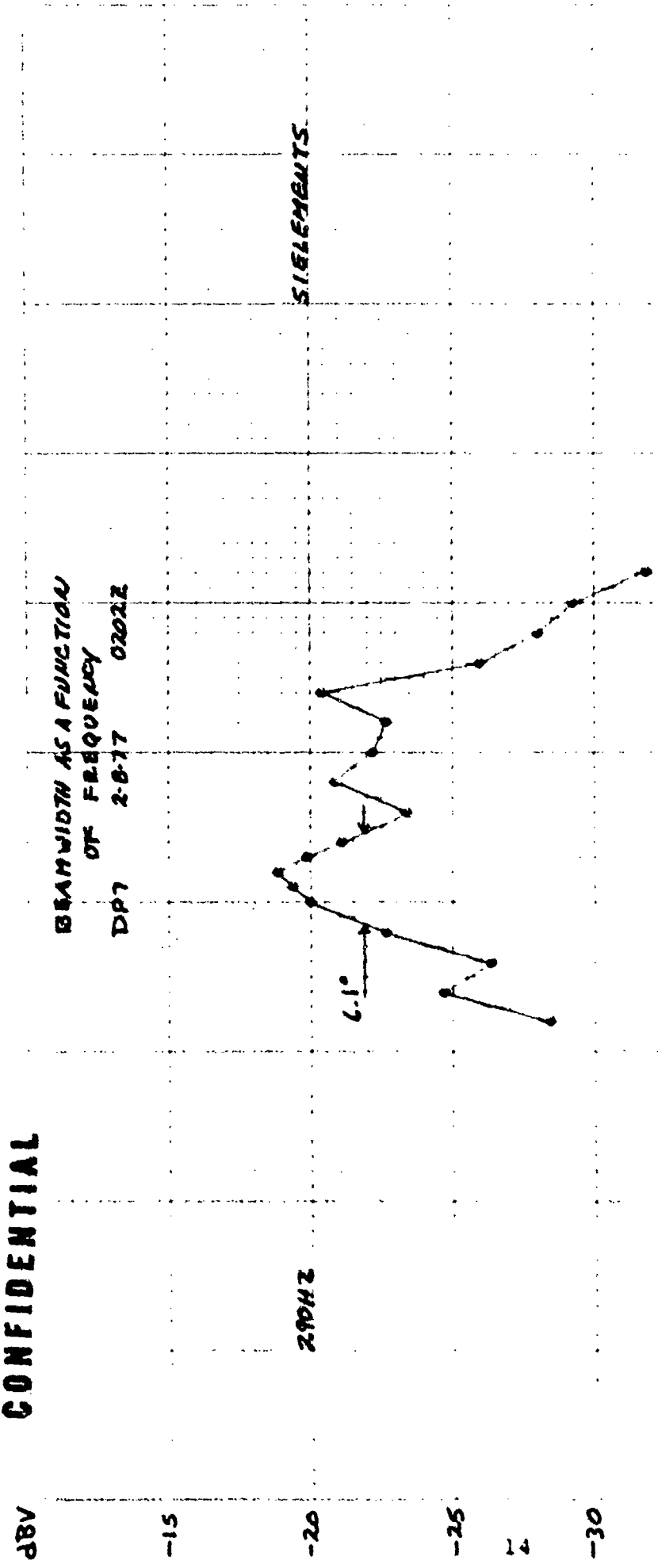


Figure 2-6 Measured Pattern Response for 51-Element Array @ 290 Hz for Data Point 7.
Main Lobe is Almost 3 Times Theoretical - Other Interference is Evident

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-10 -20 -30 -40 -50
DEGREES OFF BROADSIDE

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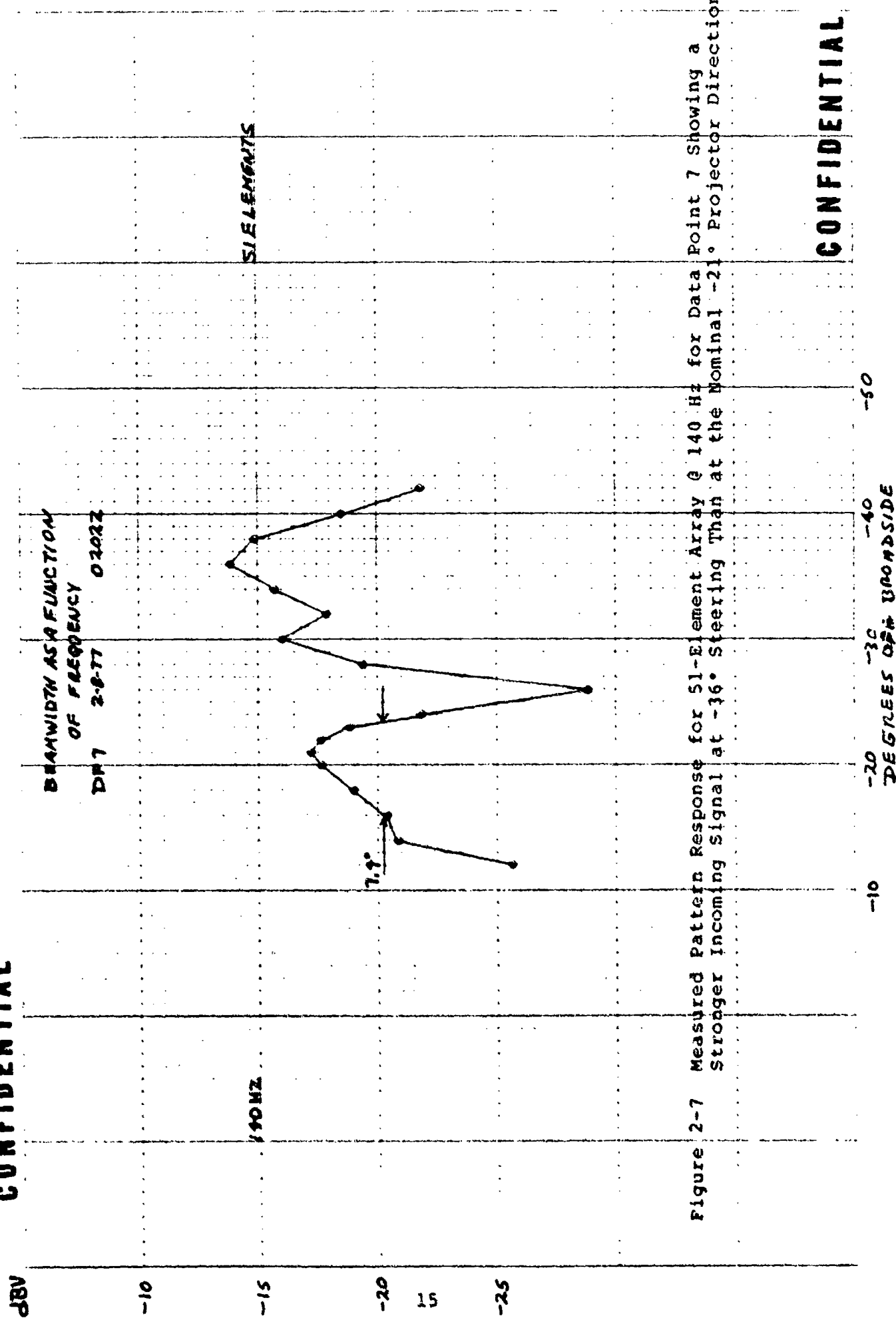


Figure 2-7 Measured Pattern Response for 51-Element Array @ 140 Hz for Data Point 7 Showing a Stronger Incoming Signal at -16° Steering Than at the Nominal -21° Projector Direction

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(S) On this assumption, it can be seen that the reported array gain of 8.5 dB (Ref Table 1-3, Vol Ia) at 140 Hz is pessimistic, and according to Figure 2-7, the measured gain should probably be stated as 11.9 dB based on considering the -36° steered "MRA" response.

(S) Observations of local interference in the Ship's log indicate the presence of six ships within a 10 NM radius of the array deployment including the monitoring ship (USNS Wilkes). Other traffic is included below:

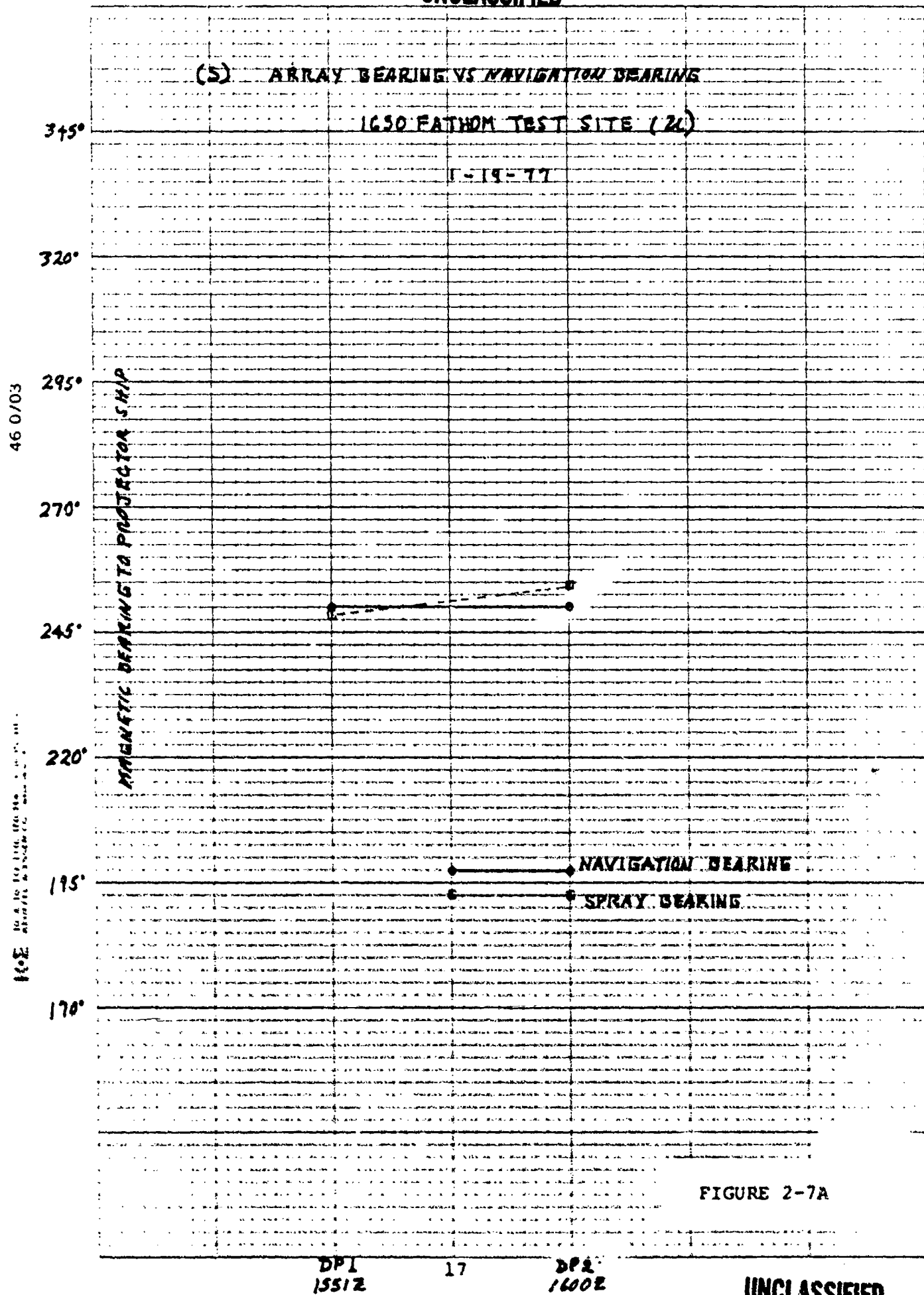
<u>True Bearing</u>	<u>Range</u>	<u>Vessel Description</u>
158 $^{\circ}$	3 NM	Soviet Oceanographic Ship Soviet Tender
178 $^{\circ}$	28 NM	USNS Kingsport
182 $^{\circ}$	9 NM	Two other Soviet Vessels (Destroyers?)
183 $^{\circ}$	7 NM	US Minesweeper
	1 NM	USNS Wilkes

All of the "measured" beamwidth plots appear in Appendix C for reference.

2.4 BEARING ACCURACY - COMPARISON WITH NAVIGATION DATA (U)

(S) Array bearing accuracy measurements were made using the navigation data as a reference for data points 1 through 7 in Sites 1A and 3. In Site 4, the array compass data was noisy and could not be used to generate array target bearings. Bearing accuracy data, summarized in Figures 2-7A and 2-7B, shows extremely good accuracy. This is displayed as bearing error in Table 2-4. Excluding DP 6 and 7, the mean absolute deviation bearing error measured less than 5° and the rms less than 7° . Including these data points during which time the array underwent rapid rotation, as if due to an ocean eddy, the mean absolute deviation and rms bearing errors for Site 3 increased to 26.2° and 33° .

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(S) ARRAY BEARING VS NAVIGATION BEARING

1900 FATHOM TEST SITE

2-7-77 AND 2-8-77 (U)

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14-2 14-10 14-11 14-12 14-13 14-14 14-15 14-16 14-17 14-18 14-19 14-20 14-21 14-22 14-23 14-24 14-25 14-26 14-27 14-28 14-29 14-30 14-31 14-32 14-33 14-34 14-35 14-36 14-37 14-38 14-39 14-40 14-41 14-42 14-43 14-44 14-45 14-46 14-47 14-48 14-49 14-50 14-51 14-52 14-53 14-54 14-55 14-56 14-57 14-58 14-59 14-60 14-61 14-62 14-63 14-64 14-65 14-66 14-67 14-68 14-69 14-70 14-71 14-72 14-73 14-74 14-75 14-76 14-77 14-78 14-79 14-80 14-81 14-82 14-83 14-84 14-85 14-86 14-87 14-88 14-89 14-90 14-91 14-92 14-93 14-94 14-95 14-96 14-97 14-98 14-99 14-100

MAGNETIC BEARING TO PROJECTILE SHIP

350°
325°
300°
275°
250°
225°
200°

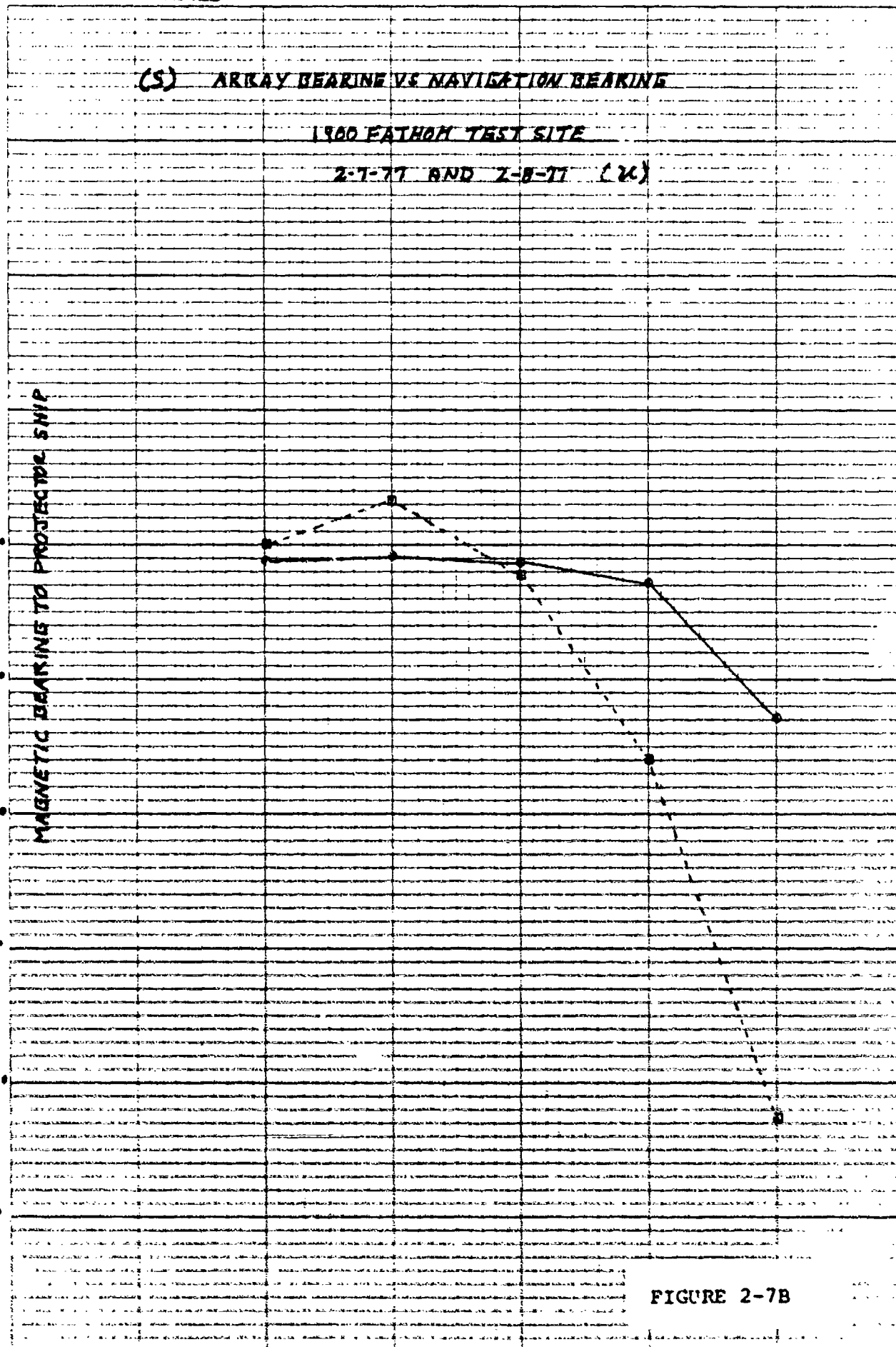


FIGURE 2-7B

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DP3
0934Z

DP4
1019Z 18

DP5
1549Z

DP6
2033Z

DP7
0202Z

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TABLE 2-4

BEARING ACCURACY SUMMARY (U)

Site	Data Point	Absolute Nav. Data Bearing	Array Bearing Error	Bearing Error MAE ²	rms
1A	1	250°	-1.5°	5.3°	6.5°
	2	250°	+9°		
3	3	372°	+2.5°		
	4	323°	+10°		
	5	322°	-3°	-26.2°	33° (1)
	6	318°	-33°		
	7	393°	-65°		
4	Absolute bearing data available from array				

(1) Excluding DP 6 and 7, during which time a relatively rapid rotation of the array was occurring, we have for Site 3

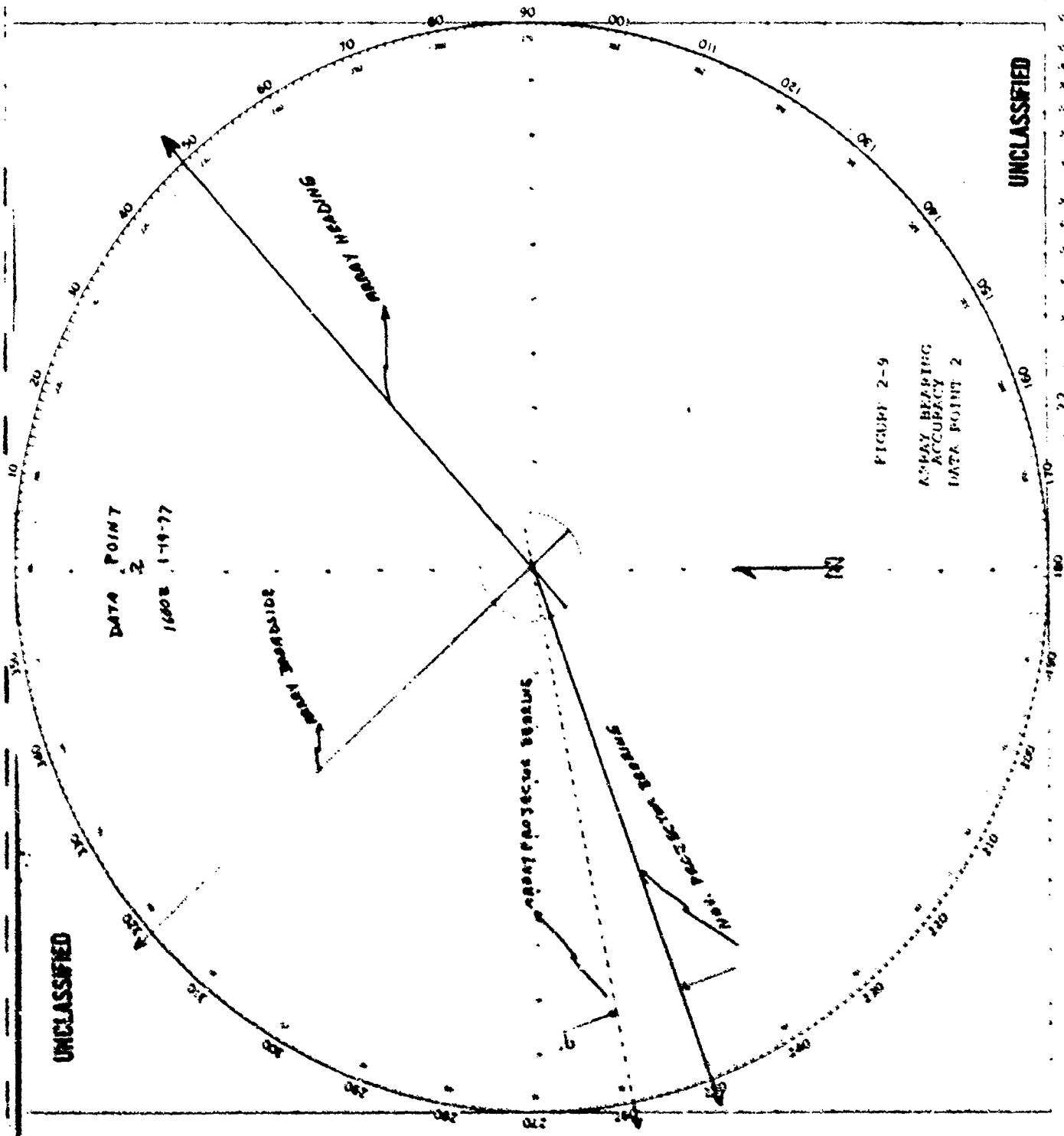
$$\begin{aligned} \text{MAE}^2 &= 4.6^\circ \\ \text{rms} &= 6.1^\circ \end{aligned}$$

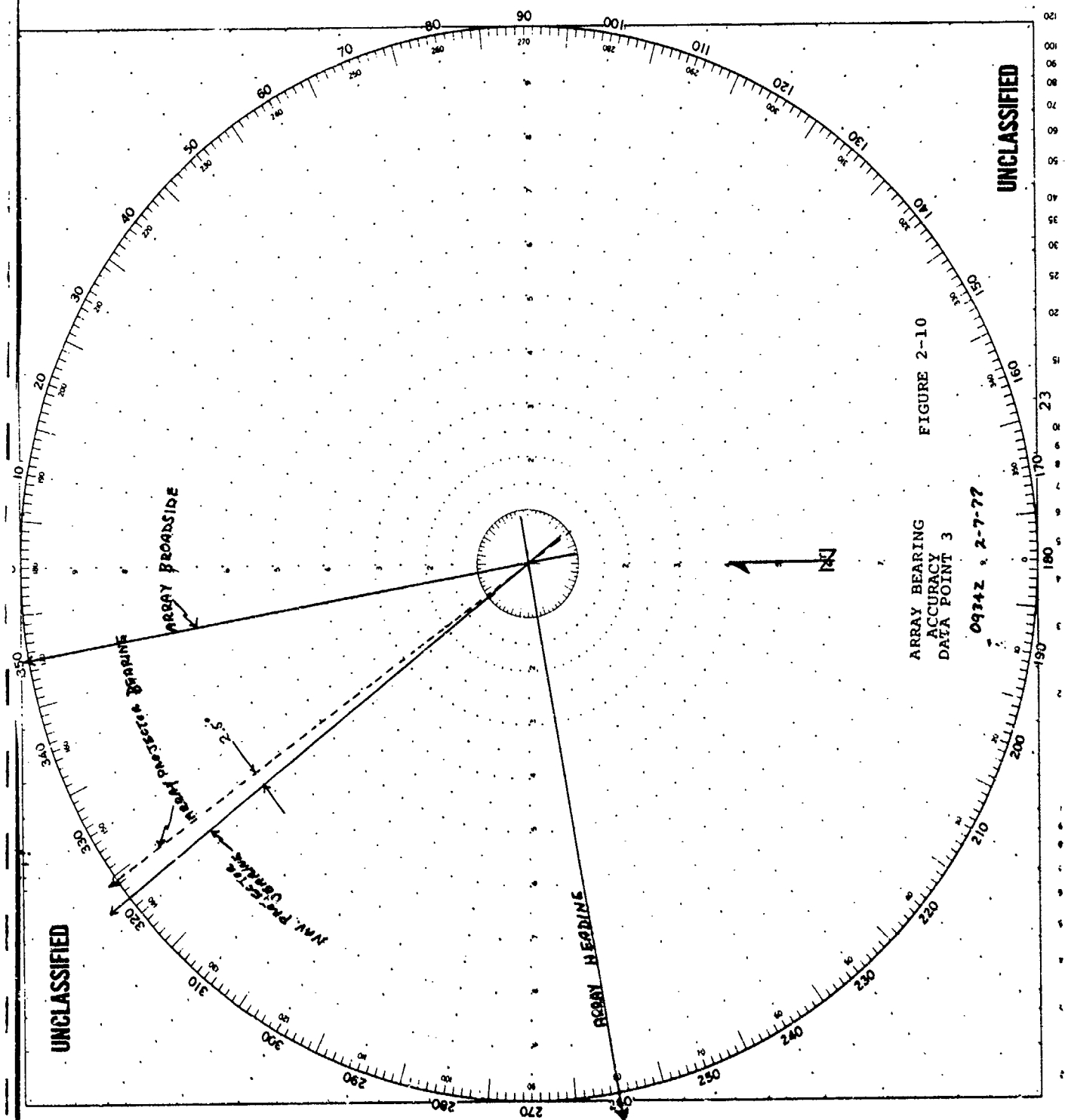
(2) MAE = Mean Absolute Deviation

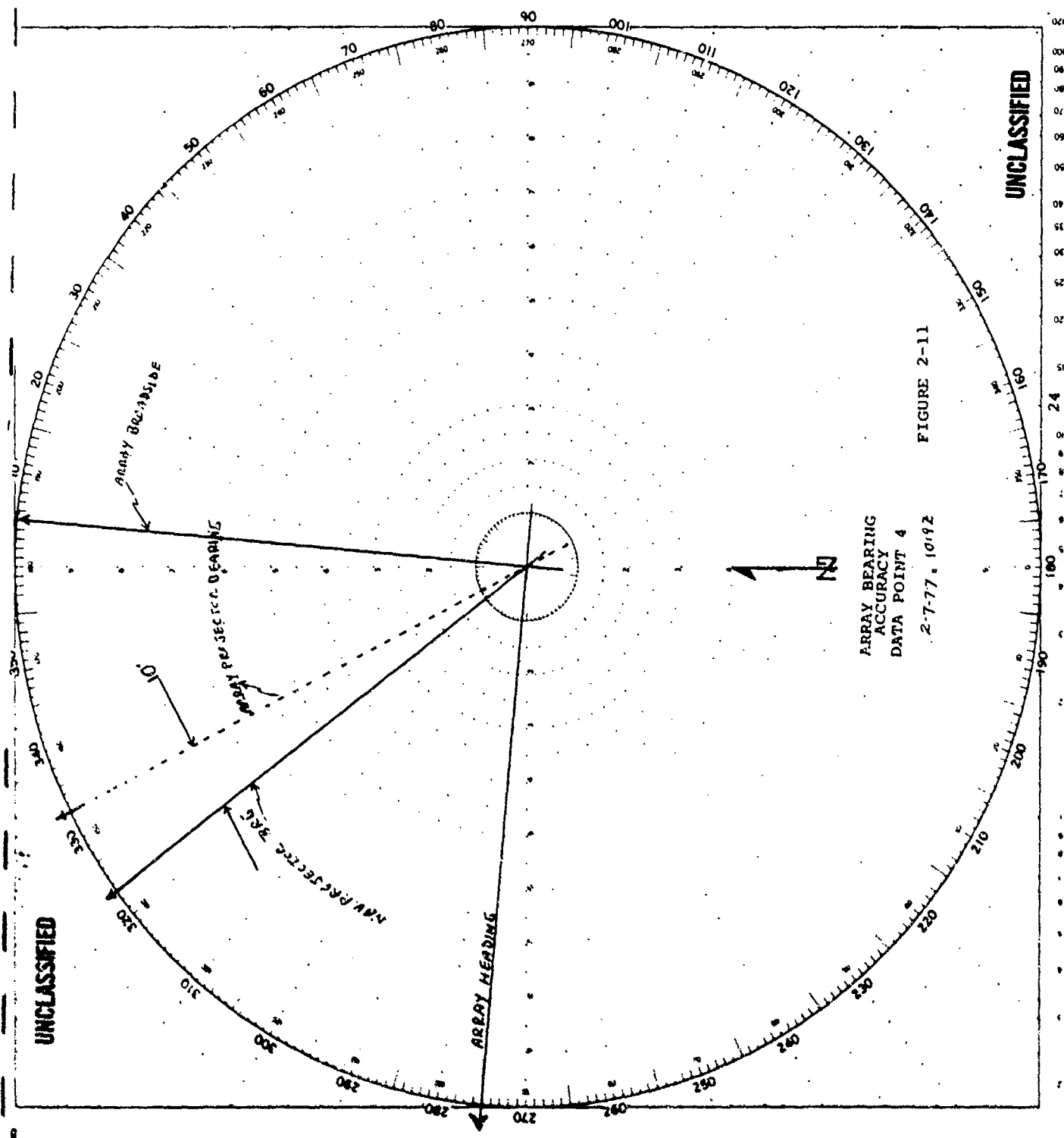
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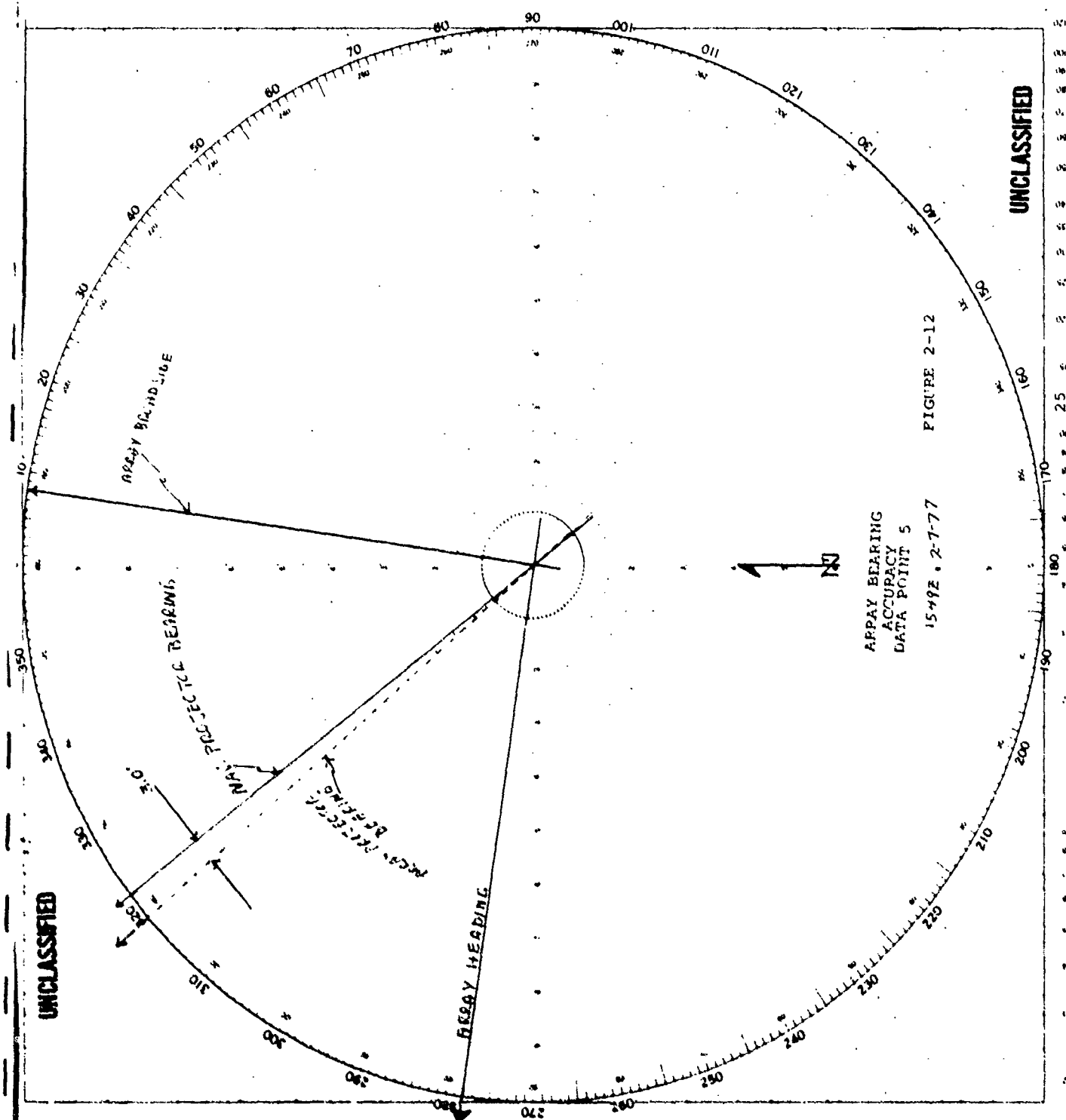
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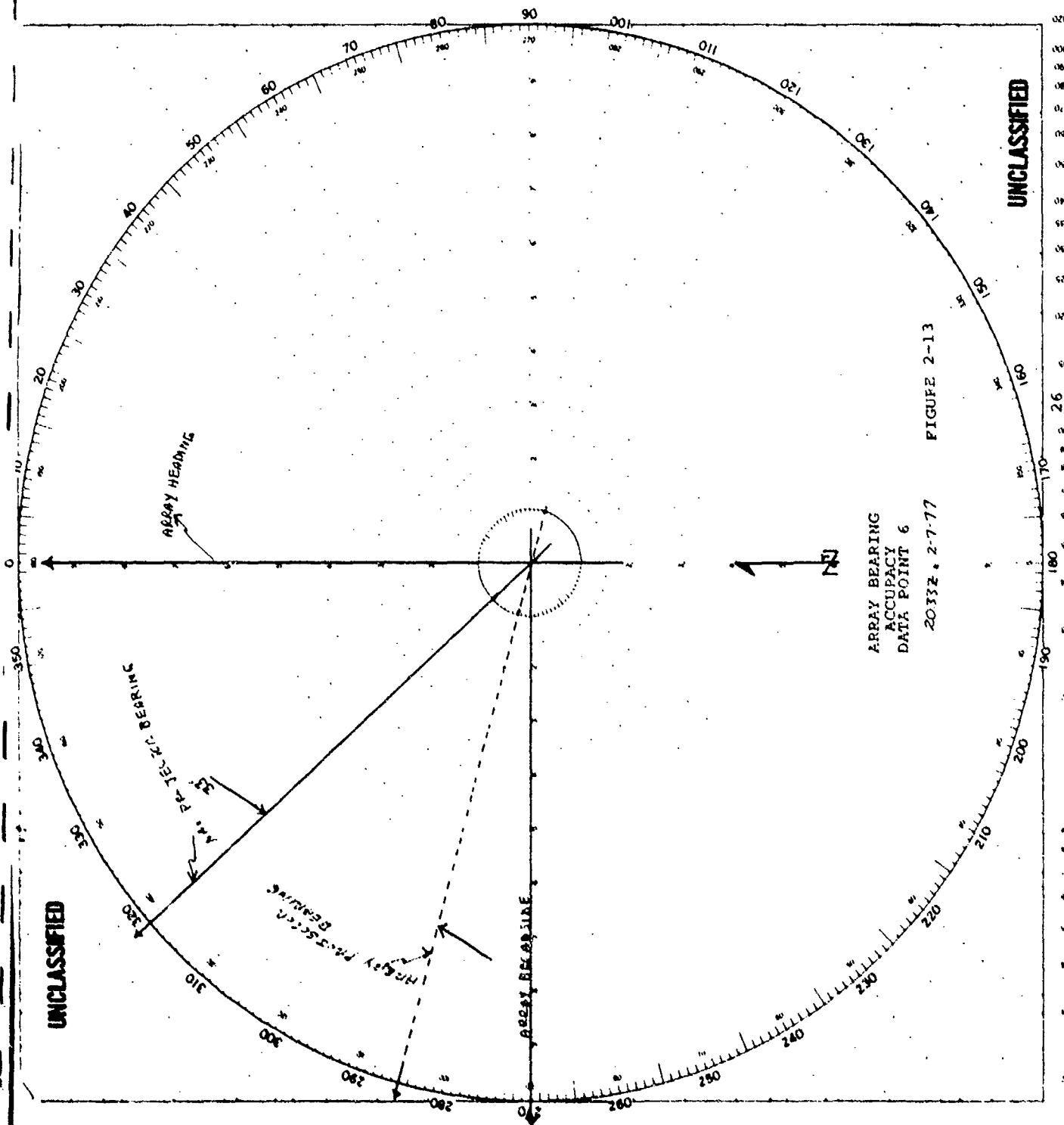
(S) Figures 2.8 through 2.14 are the actual work sheets used in determining bearing errors. Array heading, array broadside and computed (from compass and steering data) projector bearing are plotted along with the navigation data of the projector.

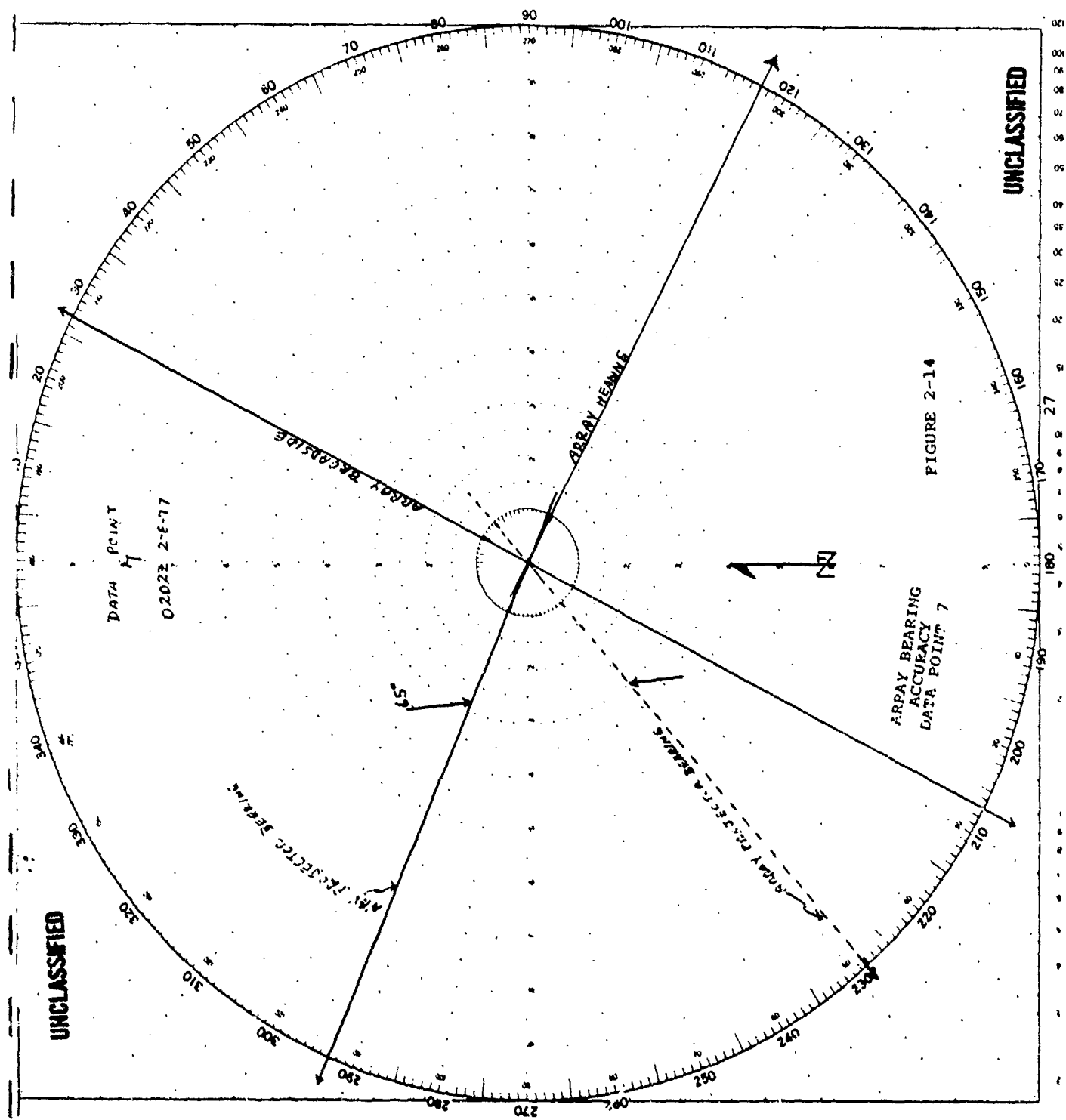












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2.5 SUMMARY AND COMPARISON OF ARRAY PERFORMANCE MEASURES (U)

(U) The purpose of this section is to summarize and compare all of the measured array data with theoretical performance. Table 1-2 (Vol IB) compiles results of all the measured data with the exception of signal gain which has a theoretical value of $20 \log$ (number of elements). Comparison of measured and theoretical signal gains are given in Figures 2-1 and 2-2, and on the figures in Appendix A, and will be summarized presently along with beamwidth and array gain data.

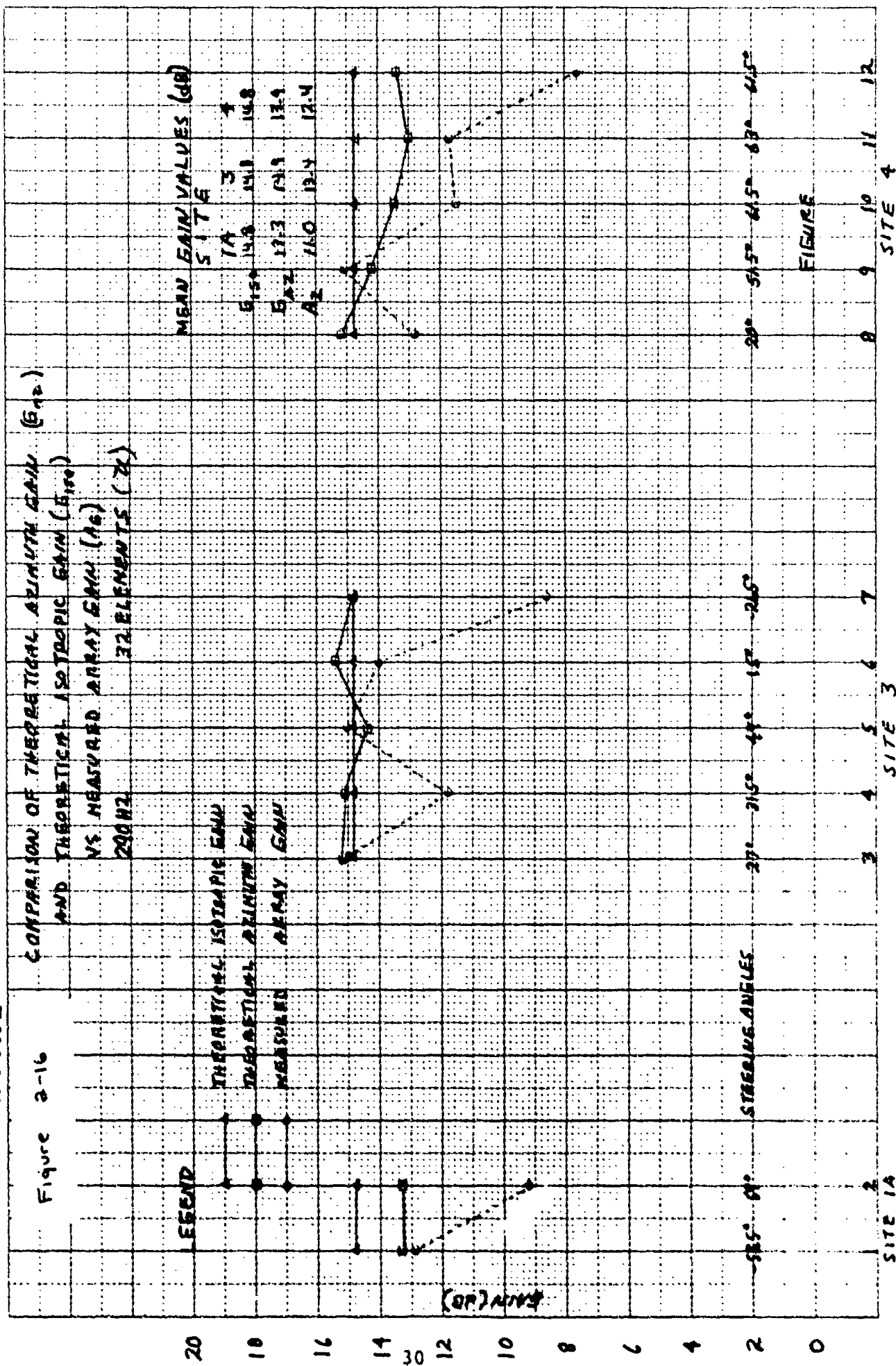
(U) Figures 2-15 through 2-23 compare measured array gain, AG, against two theoretical measures of array gain, G_{AZ} and G_{ISO} , under ideal conditions. The steps involved in the determination of measured array gain are discussed in detail in Volume II, Section 3 of this report.

(U) A brief description of the theoretical measures is in order. Azimuth gain, G_{AZ} , is the array gain that results when a two dimensional isotropic noise field (lying entirely in the azimuth plane) is considered. The entire signal is assumed incident on the array maximum response axis MRA, and thus, G_{AZ} is a measure of the array's noise discrimination in the horizontal plane. Isotropic (noise) gain, G_{ISO} , is just the familiar directivity index (DI) of the array, defined similar to azimuth gain except that a three dimensional, isotropic noise field is hypothesized. G_{ISO} is, therefore, a measure of the array's noise rejection characteristic over a three dimensional uniform noise field.

(U) Convenient approximate expressions for azimuth and isotropic gain for a line array of omni directional elements are given as follows:

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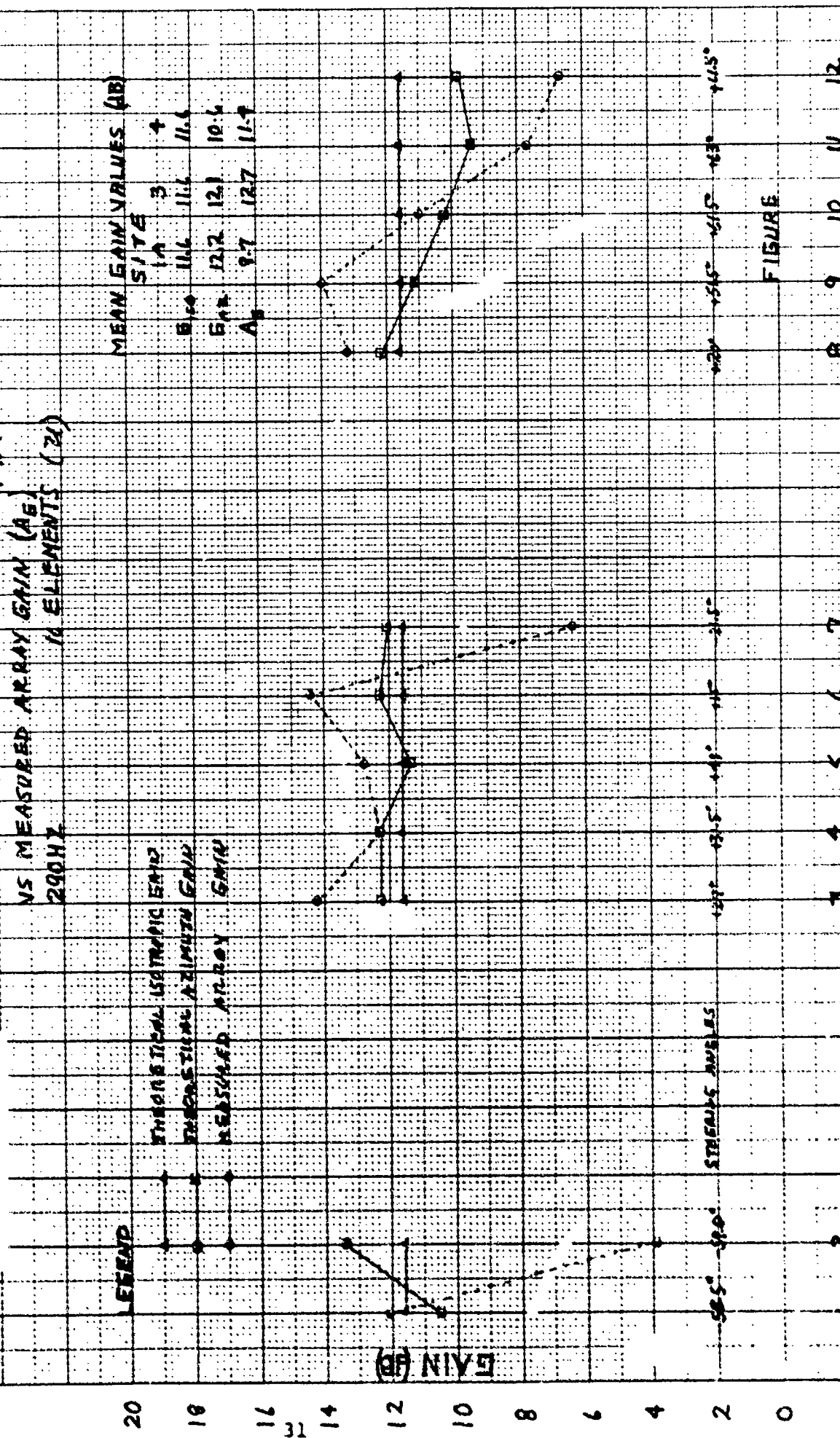


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Figure 2-17

COMPARISON OF THEORETICAL AZIMUTH GAIN (G_{AZ})
AND THEORETICAL ISOTROPIC GAIN (G_{ISO})
VS MEASURED ARRAY GAIN (G_A)
200 HZ



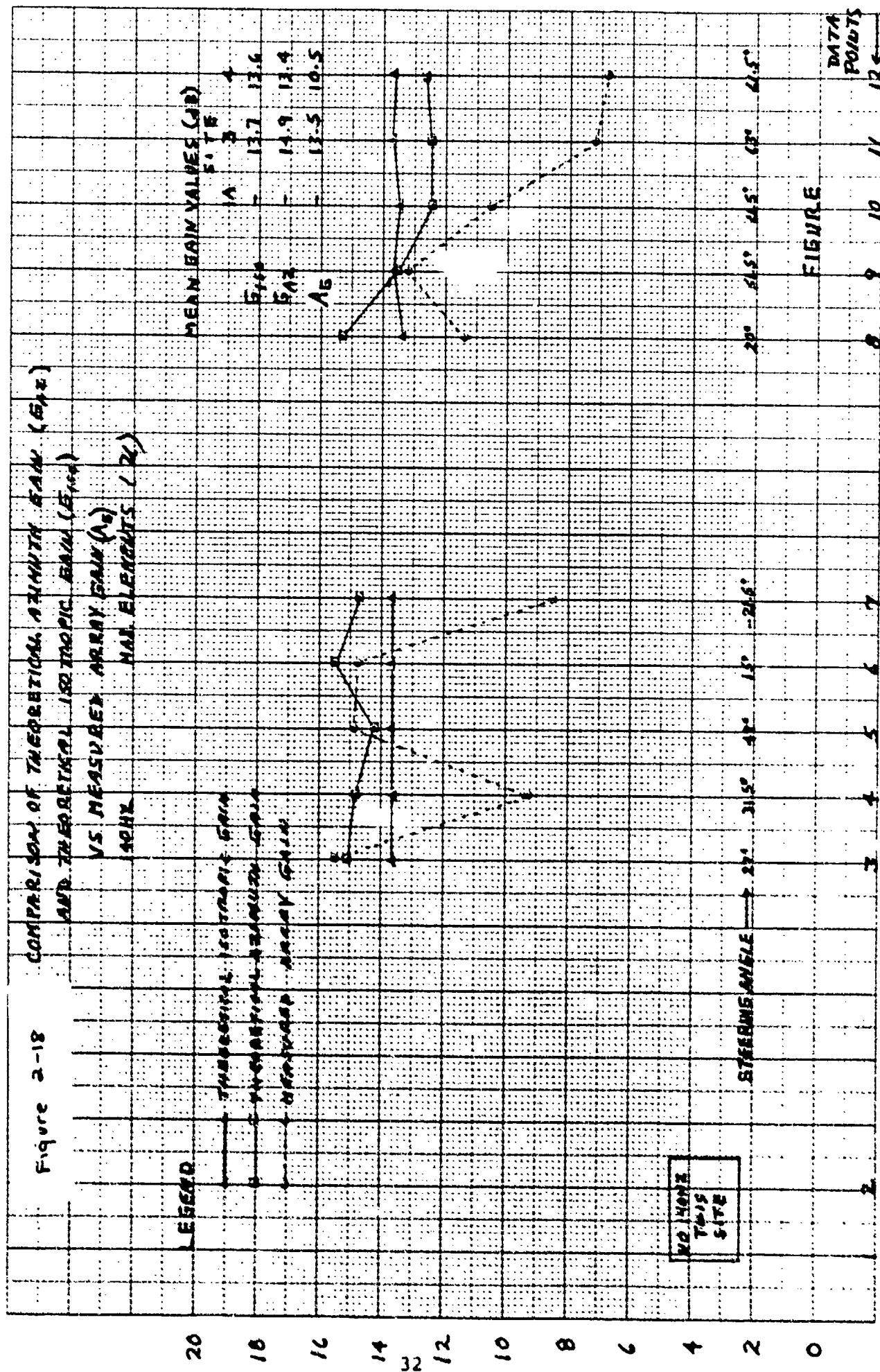
SITE 4

CONFIDENTIAL

SITE 3

SITE 1A

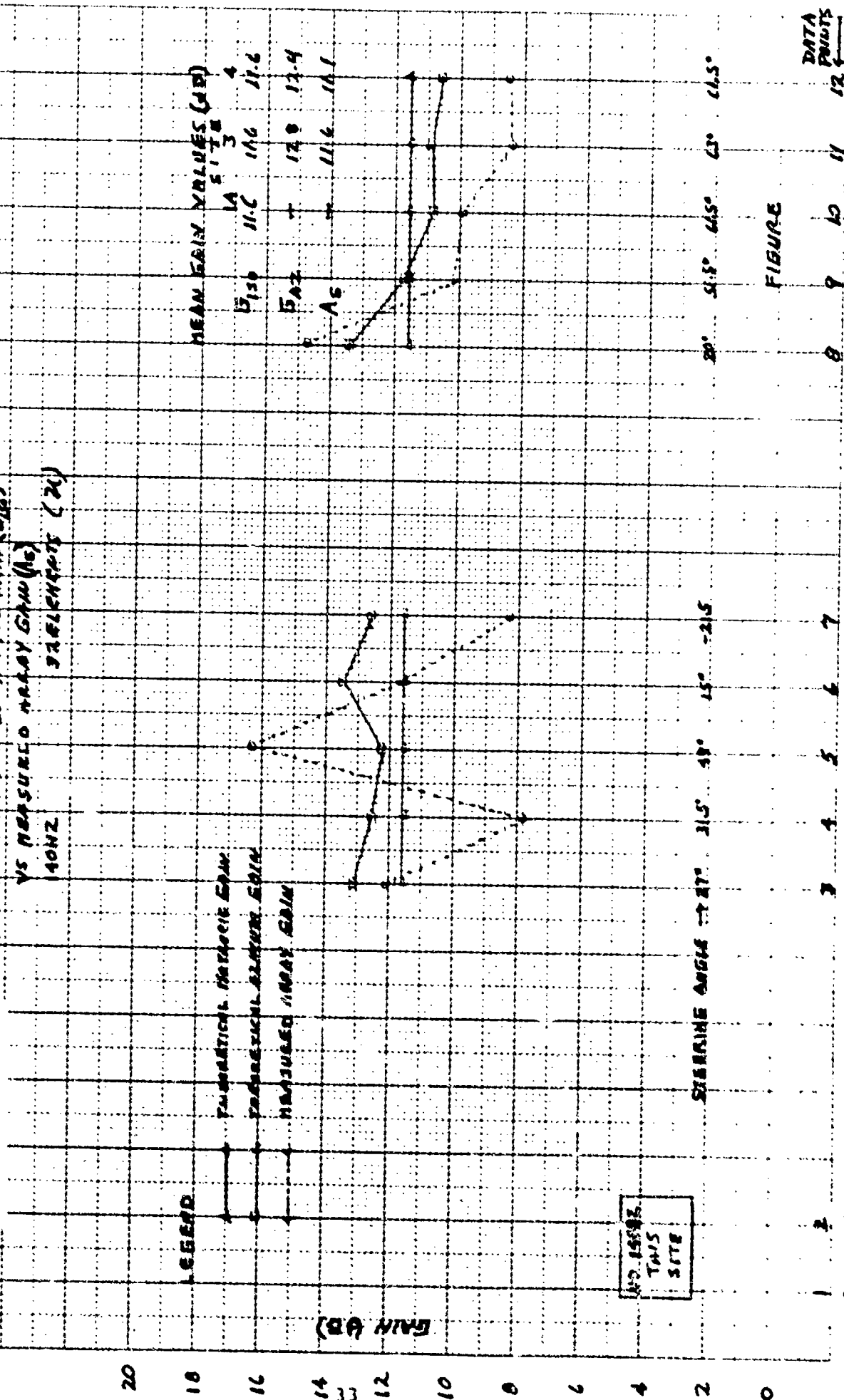
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Figure 2-19

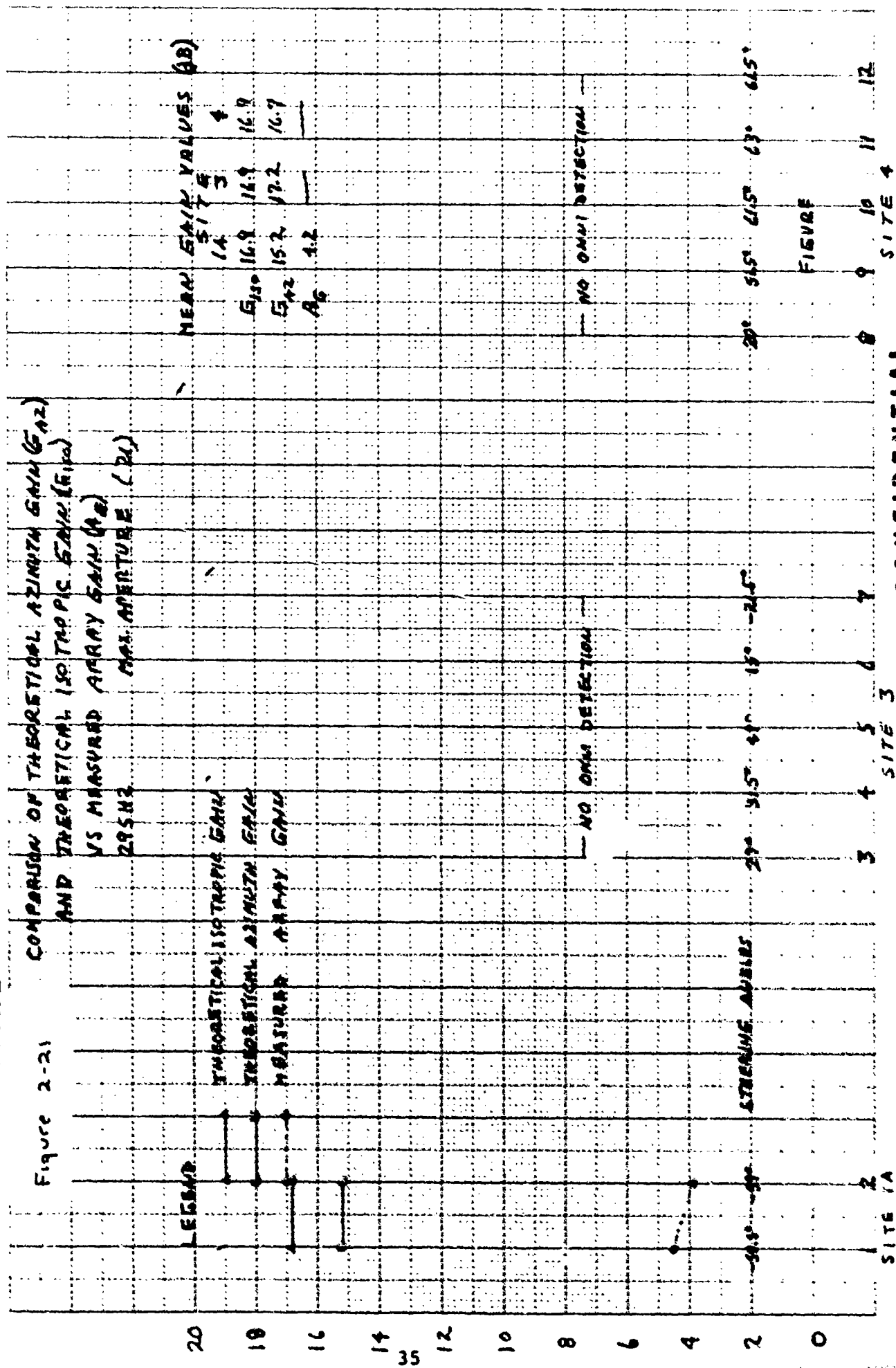
COMPARISON OF THEORETICAL 15° TROPIC RAIN (G_{15})
AND THEORETICAL 15° TROPIC RAIN (G_{15})
VS MEASURED ARRAY GAIN (G_A)
140HZ



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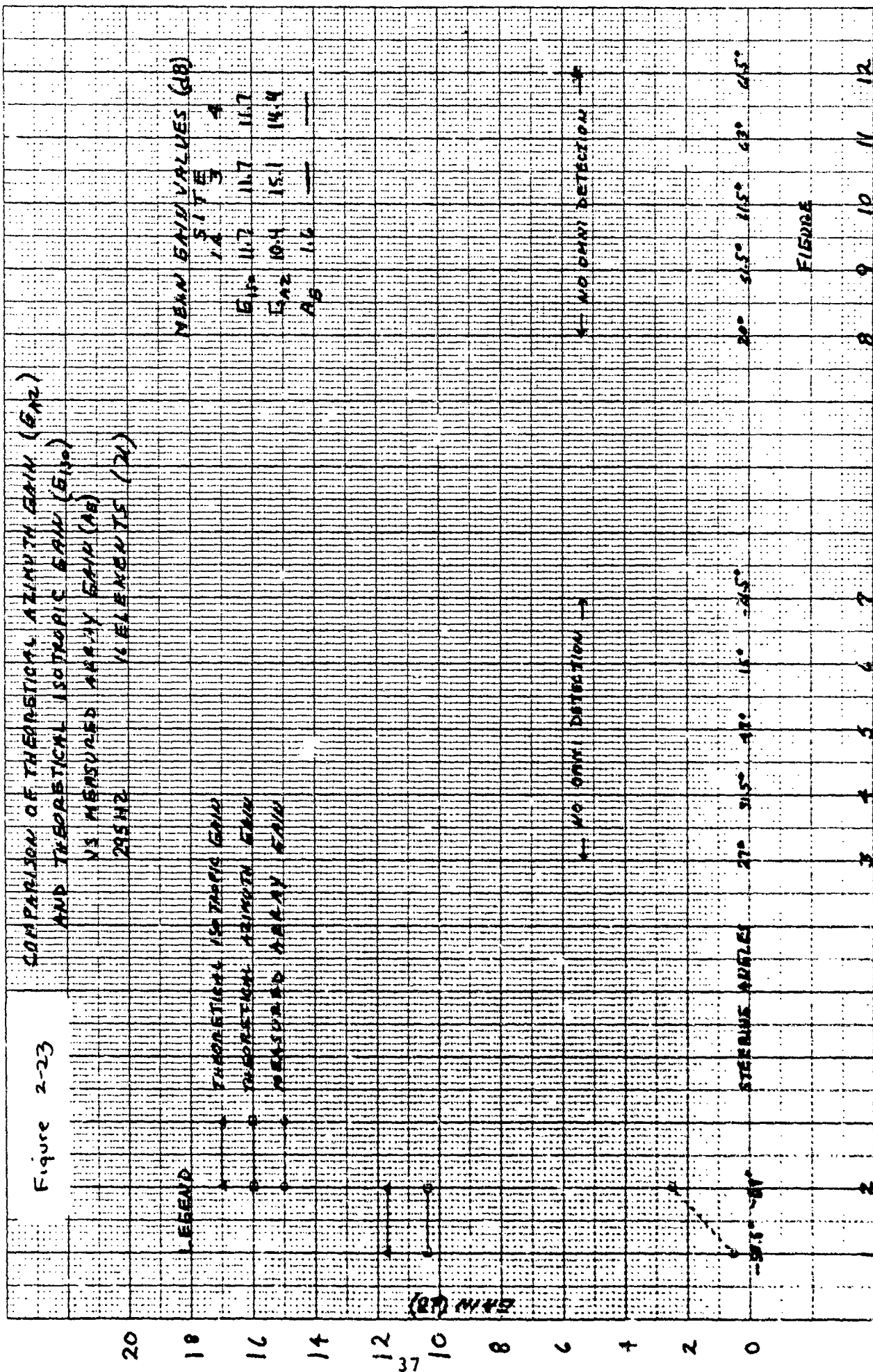
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Figure 2-21
COMPARISON OF THEORETICAL AZIMUTH GAIN (G_{AZ})
AND THEORETICAL ISOTROPIC GAIN (G_{ISO})
VS MEASURED ARRAY GAIN (A_G)
29542
MAX. APERTURE (M)



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$$G_{ISO} = 10 \log (2 L/\lambda) = 10 \log (101.6^\circ/\theta_{3B}^\circ) \text{ dB} \quad (2-2)$$

$$G_{AZ} = 10 \log \left[\pi (L/\lambda) \cos \theta_o \right] = 10 \log (159.6^\circ/\theta_3^\circ) \text{ dB} \quad (2-3)$$

where

L = array length

λ = acoustic wavelength

θ_{3B}° = the 3 dB beamwidth in degrees when the array is steered to broadside

θ_3° = the 3 dB beamwidth in degrees independent of the steering imposed

and

θ_o is the beam steering angle off broadside.

(U) In addition to plotted gain, the summary figures contain mean theoretical and measured gain values for each site, and steering angles, which affect azimuth gain. These figures show that the measured array gain tends to correlate somewhat better with azimuth gain than isotropic gain (against which it was compared in Figures 2-1, 2-2 and the figures in Appendix A).

(U) In summarizing beamwidth measurements, it was found convenient to plot broadside equivalent beamwidth, obtained from measured values by adjusting for the steer angle:

$$\hat{\theta}_{3B} = \hat{\theta}_3 \cos \hat{\theta}_o, \quad (2-4)$$

where

$\hat{\theta}_3$ = measured beamwidth at measured steer angle $\hat{\theta}_o$.

$\hat{\theta}_{3B}$ = broadside equivalent beamwidth.

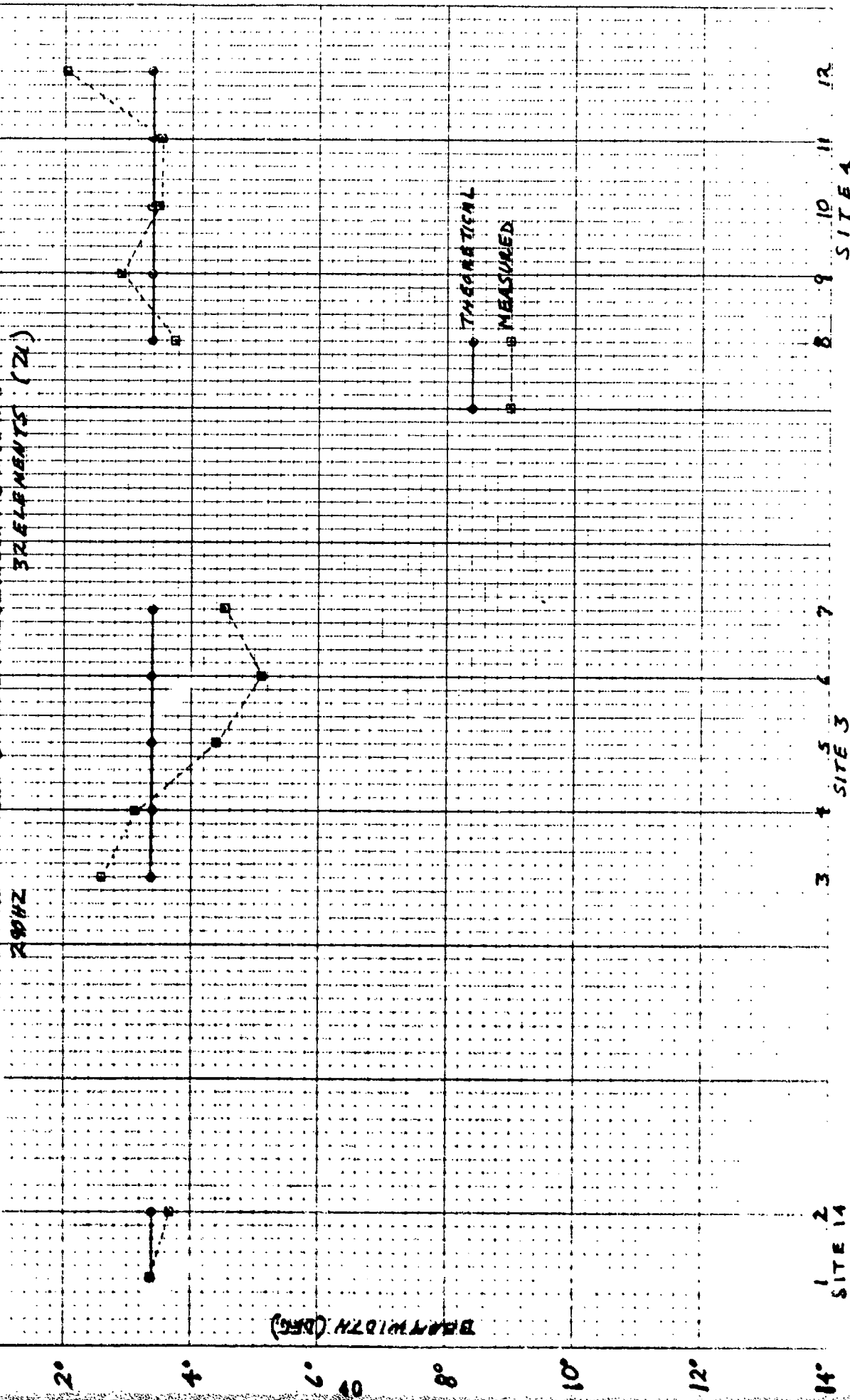
This provides a better theoretical reference for visualization of deviations from theoretical, as shown in Figures 2-24 through 2-32.

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1 Figure 2-25

MEASURED BROADSIDE EQUIVALENT BEAM WIDTH
VS THEORETICAL BROADSIDE EQUIVALENT BEAM WIDTH
200 HZ

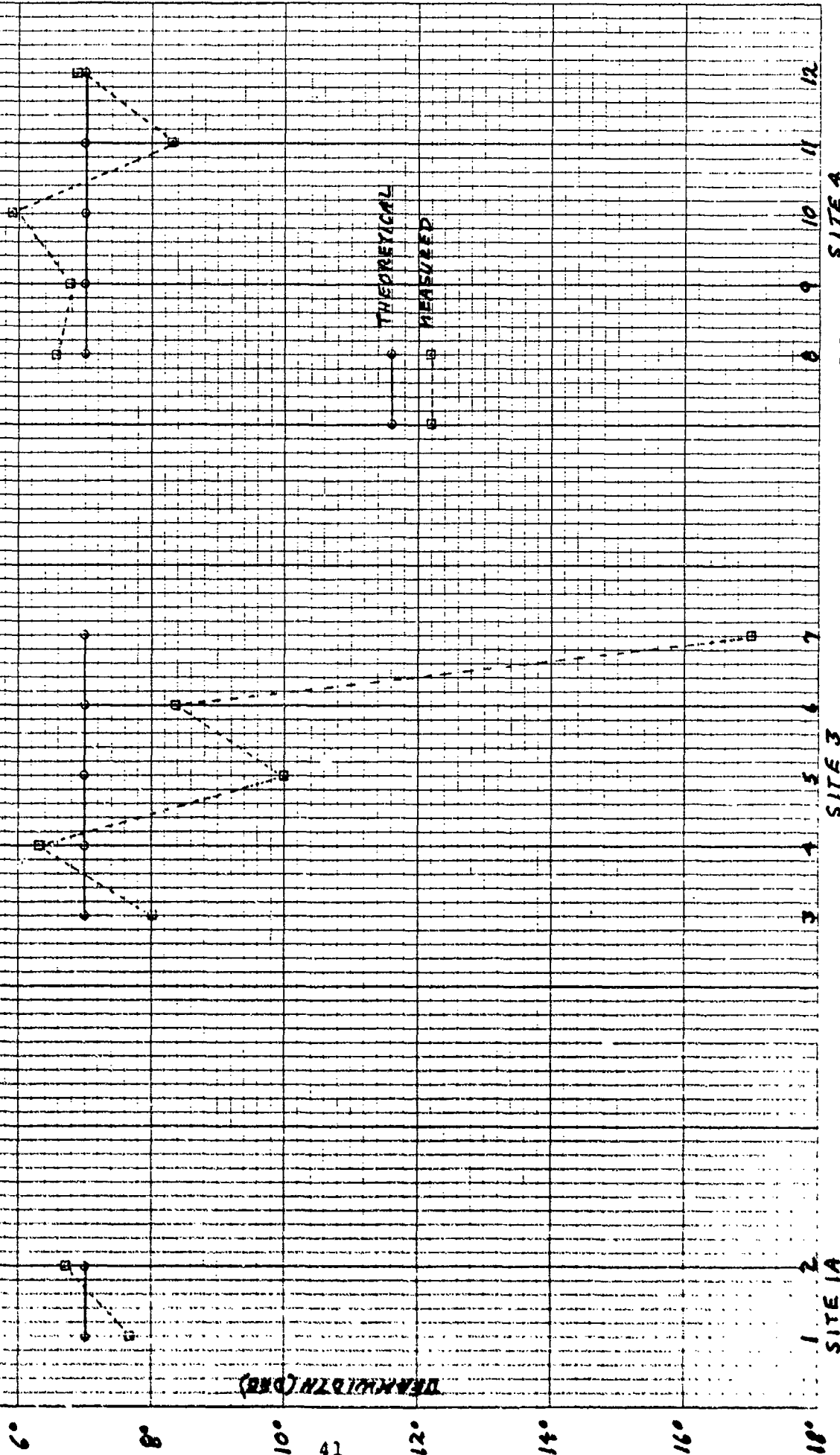


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Figure 2-26

MEASURED BROADSIDE EQUIVALENT BEAMWIDTH
VS THEORETICAL BROADSIDE EQUIVALENT
BEAMWIDTH
290 HZ
16 ELEMENTS (2X)



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Figure 2-27

MEASURED BROADSIDE EQUIVALENT BEAMWIDTH
VS THEORETICAL BROADSIDE EQUIVALENT BEAMWIDTH

MAX ELEMENTS (24)

140HZ

BEAMWIDTH (DEG)

THEORETICAL

MEASURED

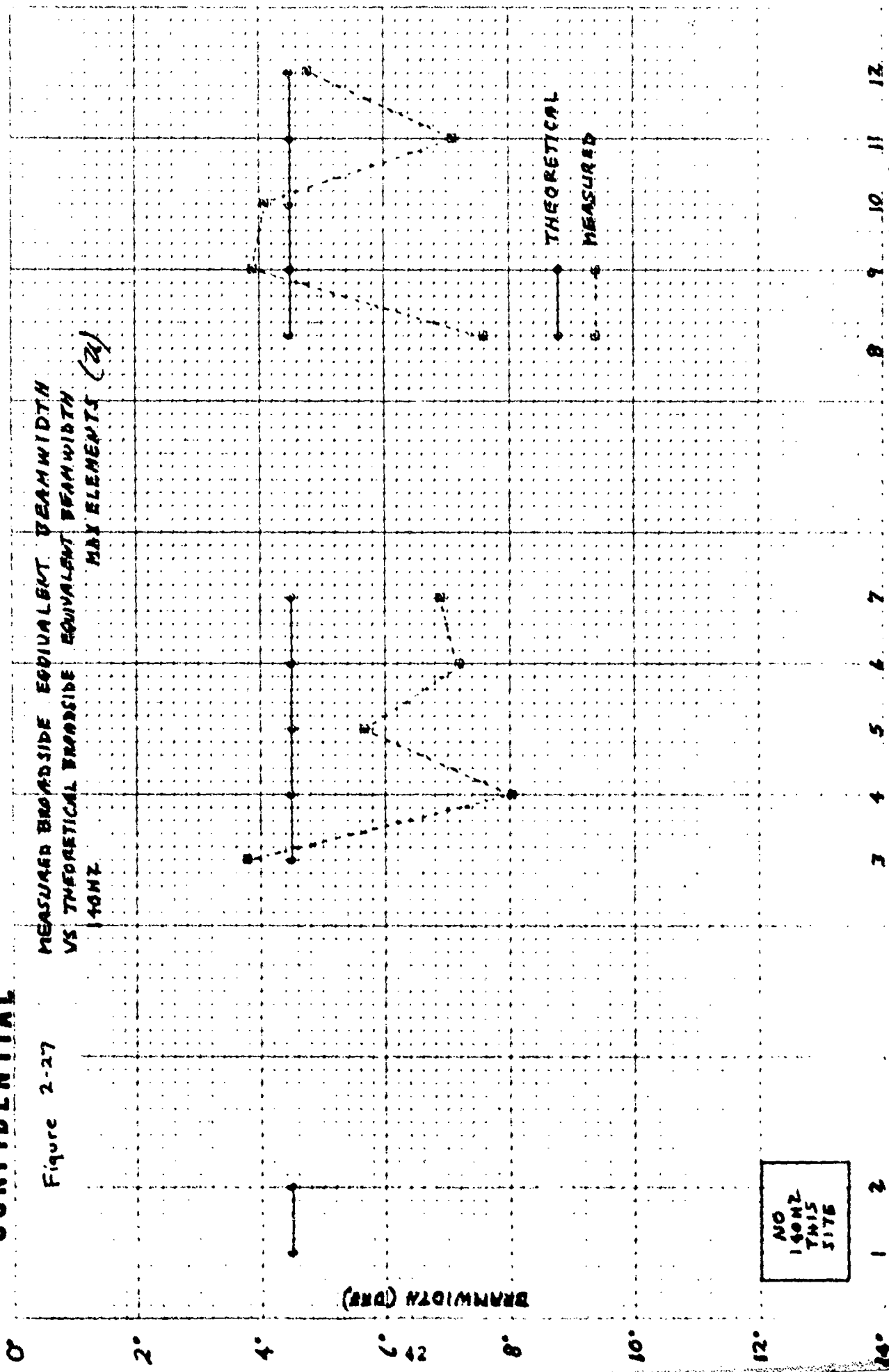
SITE 4

SITE 3

SITE 1A

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NO
140HZ
THIS
SITE



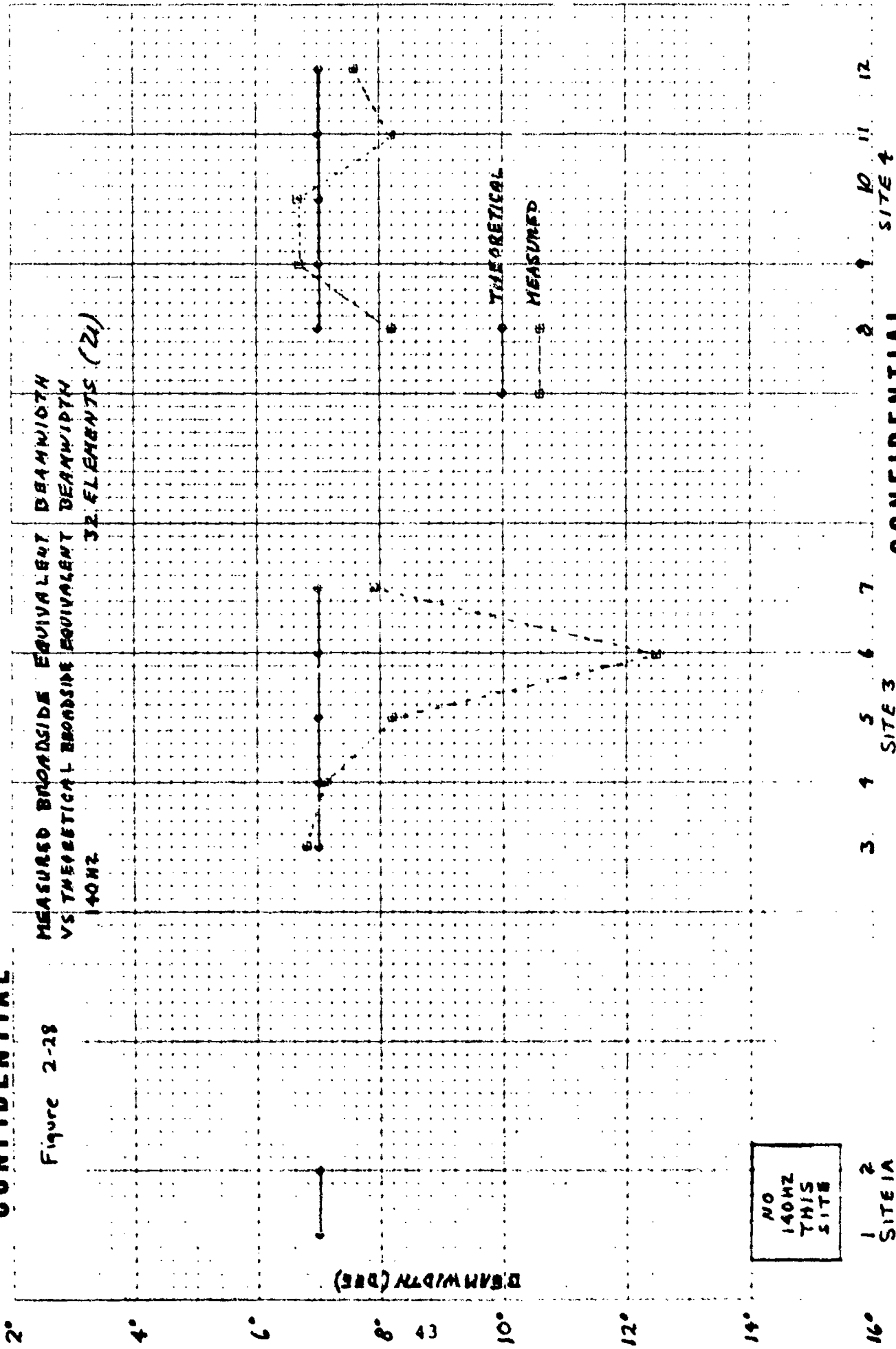
46 0703

NOE 2-28 140HZ 32 ELEMENTS (21)

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Figure 2-28

MEASURED BROADSIDE EQUIVALENT
VS THEORETICAL BROADSIDE EQUIVALENT
140HZ
32 ELEMENTS (21)

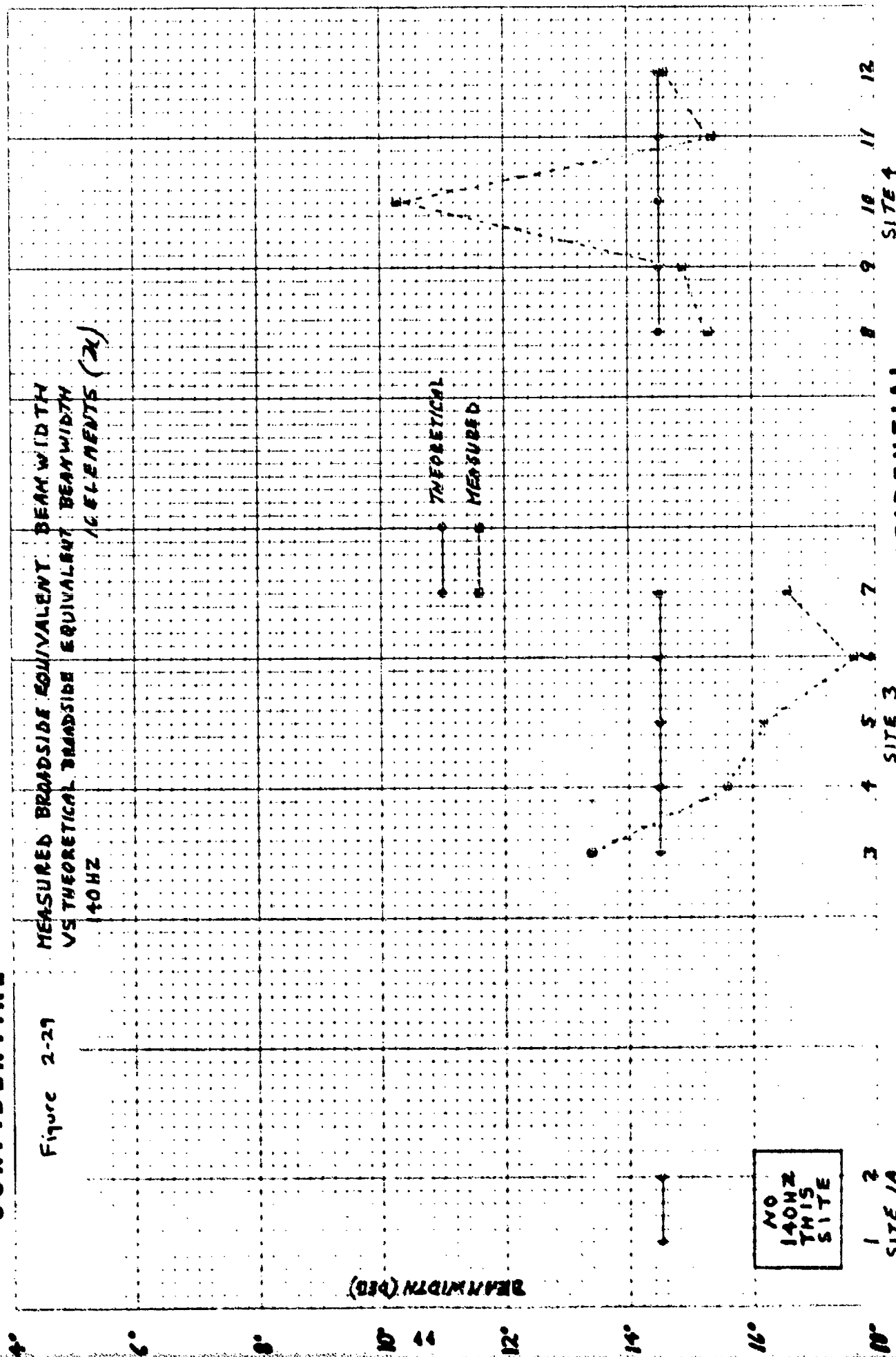


NO
140HZ
THIS
SITE

1 SITE 1A

CONFIDENTIAL

CONFIDENTIAL

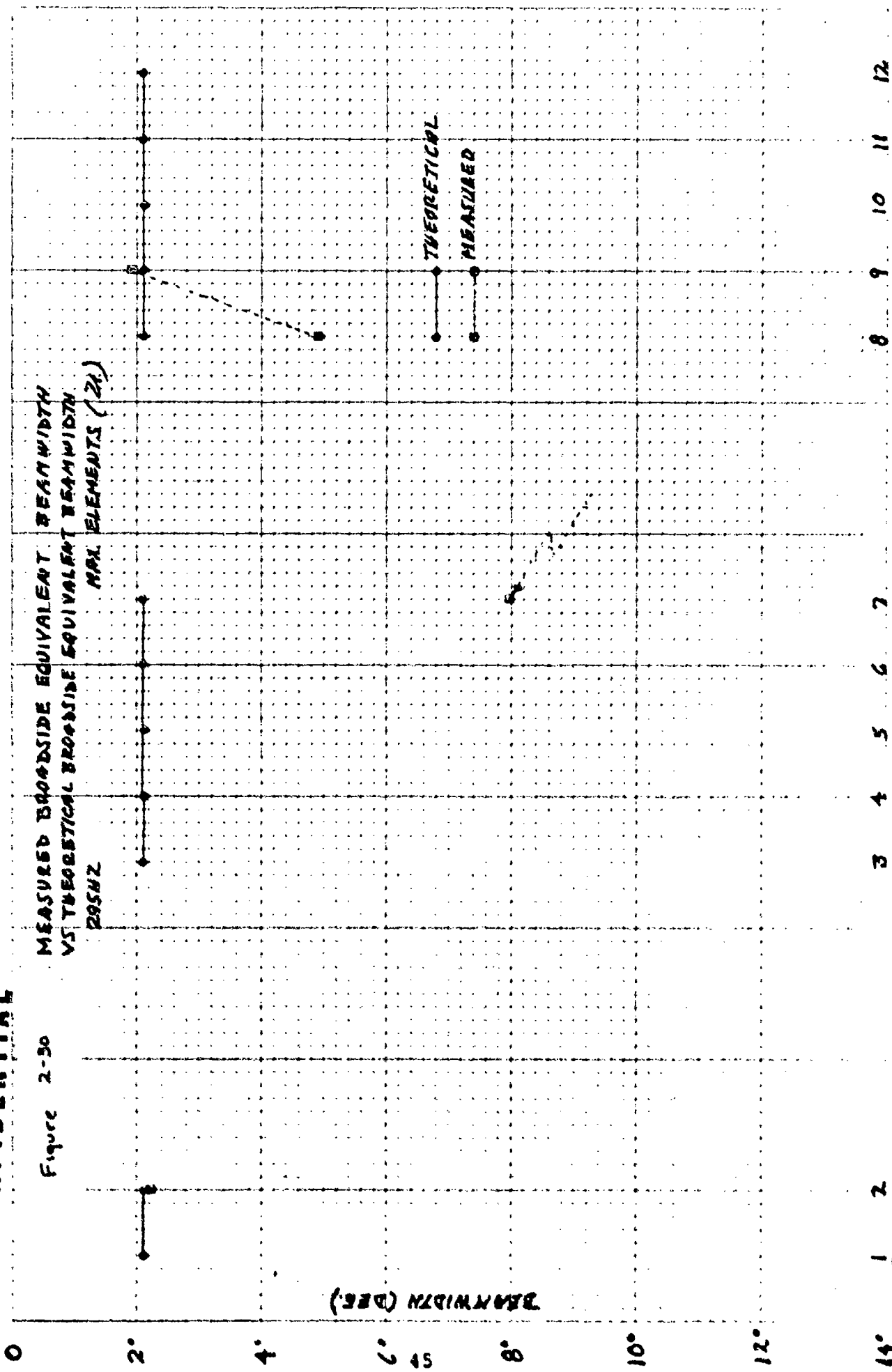


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Figure 2-30

MEASURED BROADSIDE EQUIVALENT BEAMWIDTH
VS THEORETICAL BROADSIDE EQUIVALENT BEAMWIDTH
295HZ
MAX ELEMENTS (24)



1 2
SITE 1A

3 4 5 6 7
SITE 3

8 9 10 11 12
SITE 4

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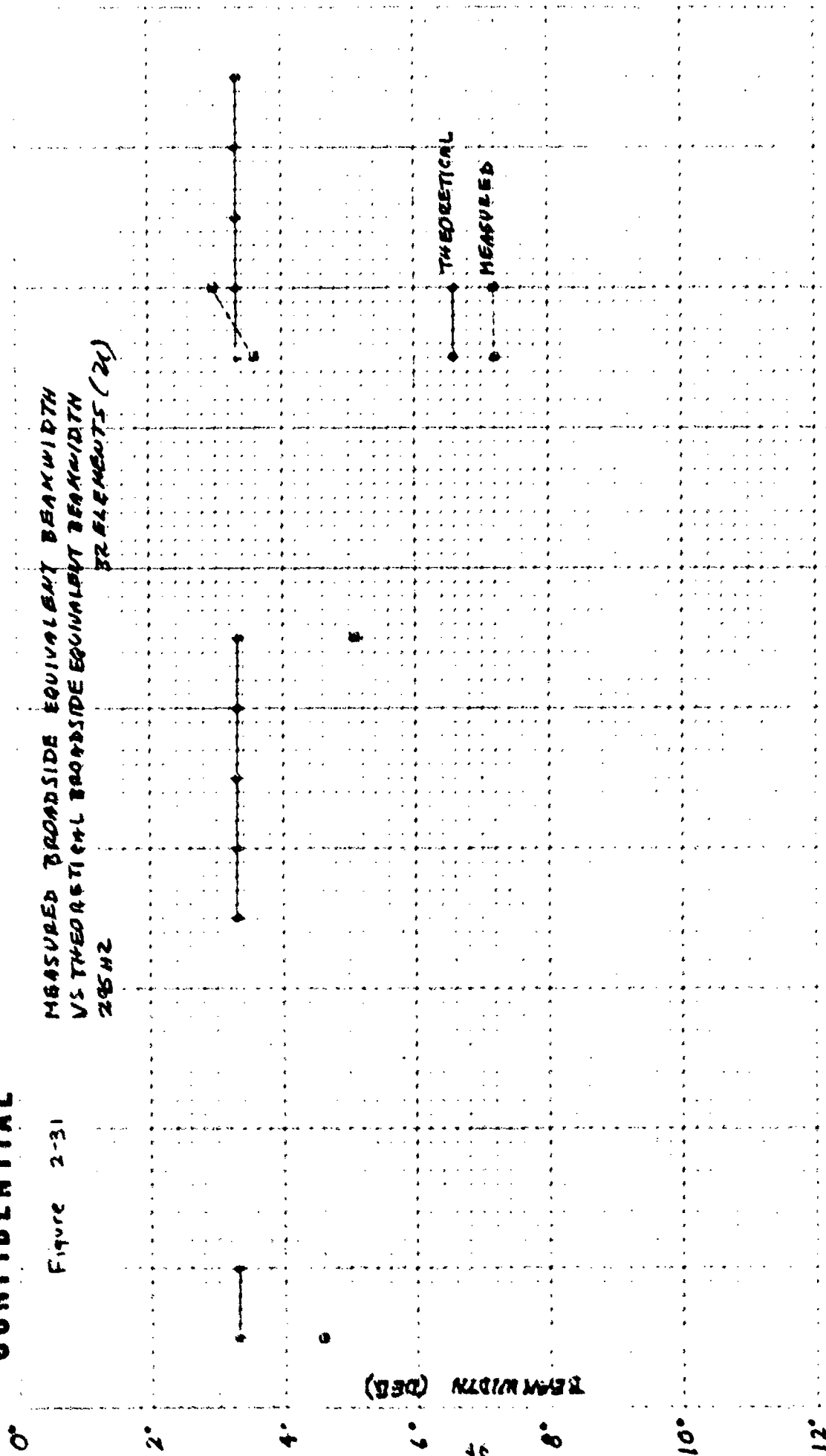
46 0103

FIG. 2-31

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Figure 2-31

MEASURED BROADSIDE EQUIVALENT BEAMWIDTH
VS THEORETICAL BROADSIDE EQUIVALENT BEAMWIDTH
285 MHz
ELEMENTS (24)



1 2
SITE 1A

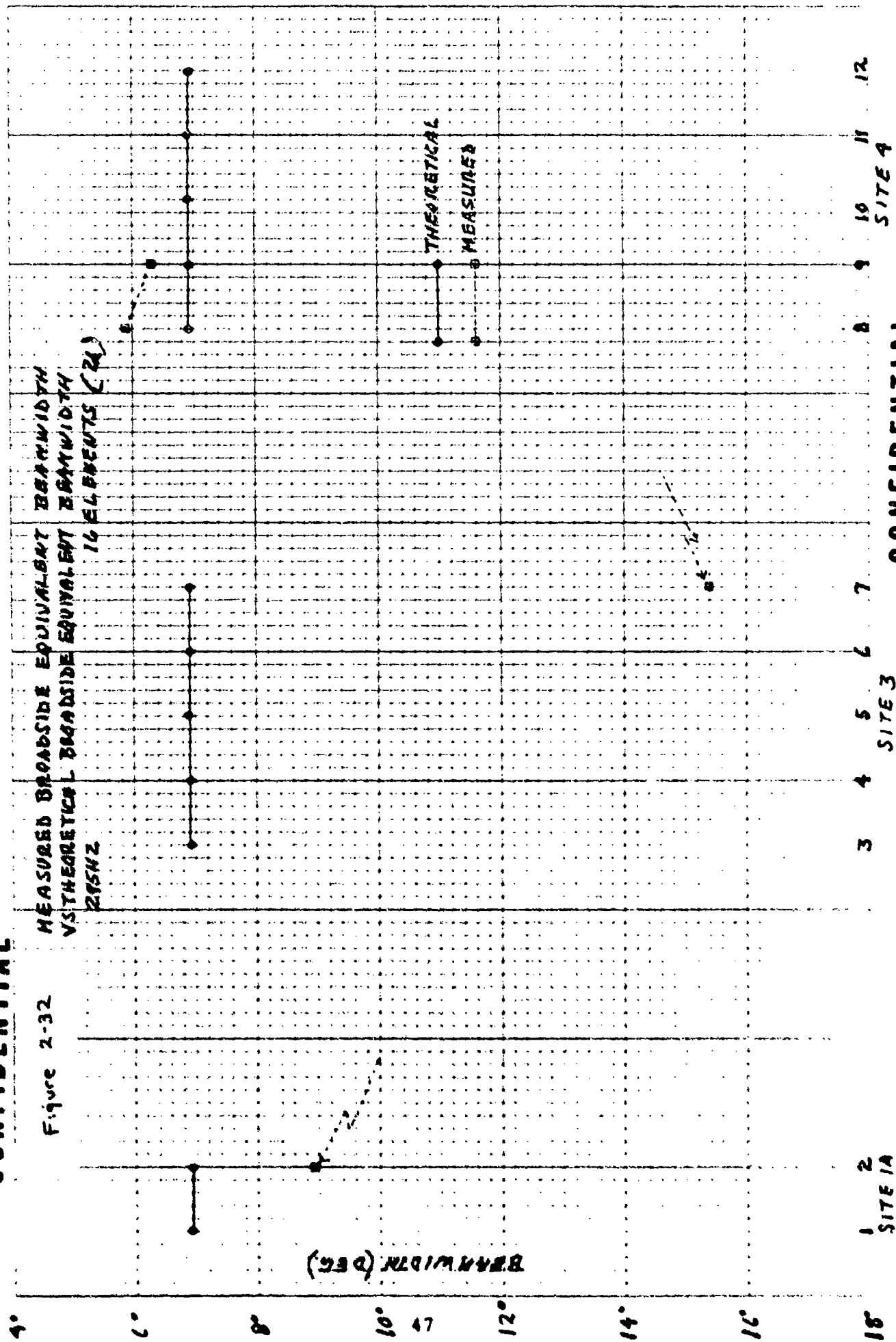
3 4 5 6 7
SITE 3

8 9 10 11 12
SITE 4

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Figure 2-32



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(U) The overall array performance summary is presented in a series of tables which contain the differences in measured performance vs theoretical. Tables 2-5 through 2-7 show beam-width differences from theoretical, and indicate mean and rms differences as a function of site and aperture size. Tables 2-8 through 2-10 summarize signal gain differences from theoretical with mean differences noted. Tables 2-11 through 2-13 list array gain differences.

(U) These last nine tables are further compressed into three array performance summary tables which present ready visualization of the BEARING STAKE results. Tables 2-14, 2-15 and 2-16 correspond to frequencies 290, 140 and 295 Hz respectively.

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(S) Table 2-5 Summary of Measured Beamwidth vs Theoretical (U)

Frequency = 290 Hz

		Beamwidth difference from theoretical for number of elements shown		
Site	DP#	16	32	MAX
1A	1	2.3°	0.7°	0.3°
	2	-0.4°	1.2°	0.9°
Mean Error		0.95°	0.95°	0.6°
rms Error		1.65°	1.0°	0.7°
3	3	1.7°	-0.6°	0.6°
	4	-0.7°	-0.1°	2.1°
	5	2.9°	2.0°	2.9°
	6	1.9°	2.1°	5.8°
	7	11.0°	1.4°	4.0°
Mean Error		3.36°	1.0°	3.1°
rms Error		5.22°	1.5°	3.5°
4	8	0°	0.7°	1.3°
	9	0.2°	-0.3°	-0.1°
	10	0.8°	1.2°	0.6°
	11	3.1°	0.9°	-0.5°
	12	0°	-2.2°	0.1°
Mean Error		0.82°	0.1°	0.3°
rms Error		1.43°	1.2°	0.7°

2.58° rms error for 36 points

2.1° rms error for full aperture (max.)

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(S) Table 2-6 Summary of Measured Beamwidth vs Theoretical (U)

Frequency = 140 Hz

		Beamwidth difference from theoretical for number of elements shown		
Site	DP#	16	32	MAX
1A	1	140 Hz not projected in Site 1A		
Mean Error				
rms Error				
3	3	-0.1°	0.3°	-0.3°
	4	1.0°	0.9°	5.1°
	5	1.4°	2.2°	2.3°
	6	3.9°	6.1°	3.3°
	7	2.2°	0.4°	2.4°
Mean Error		1.68°	2.0°	2.6°
rms Error		2.15°	2.9°	3.1°
4	8	2.2°	1.9°	3.9°
	9	1.8°	0.4°	-0.1°
	10	-2.3°	1.5°	0.1°
	11	3.8°	3.1°	6.5°
	12	-5.8°	2.1°	1.5°
Mean Error		-0.1°	1.8°	2.4°
rms Error		3.5°	2.0°	3.5°

2.91° rms error for 30 points

3.28° rms error for full aperture (Max)

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(S) Table 2-7 Summary of Measured Beamwidth vs
Theoretical (U)

Frequency = 295 Hz

		Beamwidth difference for theoretical for number of elements shown		
Site	DP #	16	32	MAX
1A	1	-	3.0°	0.4°
	2	4.0°	-	-
Mean Error		4.0°	3.0°	0.4°
rms Error		4.0°	3.0°	0.4°
3	3	-	-	-
	4	-	-	-
	5	-	-	-
	6	-	-	-
	7	9.6°	2.2°	6.5°
Mean Error		9.6°	2.2°	6.5°
rms Error		9.6°	2.2°	6.5°
4	8	-0.3°	0.7°	1.2°
	9	-0.3°	-0.1°	0°
	10	-	-	-
	11	-	-	-
	12	-	-	-
Mean Error		-0.3°	0.3°	1.6°
rms Error		0.3°	0.5°	2.26°

3.82° rms error for 12 points

3.63° rms error for full aperture (MAX)

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(S) Table 2-8 Summary of Measured Signal Gain
vs Theoretical (U)

Frequency = 290 Hz

		Signal gain difference from theoretical in dB for number of elements shown		
Site	DP#	16	32	MAX
1A	1	-6.1	-8.7	-12.2
	2	-8.8	-5.5	- 6.6
Mean Differ.		-7.2	-6.8	- 8.5
3	3	-0.2	-1.9	-2.1
	4	+0.2	-3.0	-5.7
	5	-0.5	-3.4	-4.1
	6	-4.2	-1.5	-4.4
	7	+1.6	-0.3	-4.7
Mean Differ.		-0.2	-1.9	-4.0
4	8	-1.9	+2.2	-1.6
	9	-2.3	+2.8	+1.0
	10	+0.9	+1.0	+0.1
	11	+0.7	-1.1	-0.4
	12	+3.4	+1.6	+0.1
Mean Differ.		+0.7	+1.5	-0.1

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(S) Table 2-9 Summary of Measured Signal Gain vs.
Theoretical (U)

Frequency = 140 Hz

		Signal gain difference from theoretical in dB for number of elements shown		
Site	DP#	16	32	MAX
1A	1	140 Hz not projected in Site 1A		
	2			
Mean Differ.				
3	3	+0.4	0	+1.1
	4	-0.9	-0.9	-1.95
	5	+5.1	+2.8	-0.2
	6	+0.1	-1.0	-2.1
	7	+3.3	+1.0	-1.8
Mean Differ.		+2.2	+0.6	- .8
4	8	+1.4	+2.3	-1.0
	9	-5.1	+1.6	+1.9
	10	+4.6	+3.8	+2.1
	11	+5.1	+3.3	-0.6
	12	+6.2	+4.0	+1.3
Mean Differ.		+3.8	+3.1	+0.9

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(S) Table 2-10 Summary of Measured Signal Gain
vs. Theoretical (U)

Frequency = 295 Hz

		Signal gain difference from theoretical in dB for number of elements shown		
Site	DP#	16	32	Max
1A	1	-11.6	-13.	-17.3
	2	-10.7	-11.4	-14.2
Mean Differ.		-11.1	-12.1	-15.5
3	3			
	4			
	5			
	6			
	7			
Mean Differ.				
4	8			
	9			
	10			
	11			
	12			
mean difference				

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(S) Table 2-11 Summary of Measured Array Gain
vs. Theoretical (U)

Frequency = 290 Hz

		Array gain difference from theoretical azimuth gain (dB) for number of elements shown		
Site	DP#	16	32	Max
1A	1	+1.6	-1.1	-5.4
	2	-9.6	-3.4	-4.3
Mean Differ.		-1.1	-2.1	-4.8
3	3	+1.9	-0.3	-0.4
	4	0	-3.2	-7.3
	5	+1.5	+0.6	-4.6
	6	+1.9	-1.3	-4.9
	7	-5.6	-6.1	-10.0
Mean Differ.		0.6	-1.5	-4.3
4	8	+1.1	-2.4	-6.1
	9	+2.9	-0.9	-0.5
	10	+0.8	-1.9	-2.4
	11	-1.7	-1.3	-2.8
	12	-3.1	-5.8	-8.5
mean difference		+0.5	-1.6	-3.2

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(S) Table 2-12 Summary of Measured Array Gain
vs. Theoretical(U)

Frequency = 140 Hz

		Array gain difference from theoretical azimuth gain (dB) for number of elements shown		
Site	DP#	16	32	Max
1A	1 2	140 Hz not projected in Site 1A		
Mean Differ.				
3	3	-10.8	-1.0	+0.4
	4	-6.2	-4.8	-5.5
	5	+9.0	+4.2	+0.7
	6	-1.8	-2.0	-0.7
	7	-0.0	-4.3	-6.2
Mean Differ.		+3.4	-0.2	-1.4
4	8	-4.1	+1.3	-3.9
	9	-4.7	-1.5	-0.4
	10	-1.5	-0.9	-1.9
	11	-0.2	-2.5	-5.2
	12	+1.3	-2.1	-5.8
mean difference		-1.3	-0.9	-3.0

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(S) Table 2-13 Summary of Measured Array Gain
vs Theoretical (U)

Frequency = 295 Hz

		Array gain difference from theoretical azimuth gain (dB) for number of elements shown		
Site	DP#	16	32	Max.
1A	1	-2.5	-5.1	-11.0
	2	-7.9	-8.8	-11.5
Mean Differ.		-4.4	-6.6	-11.2
3	3			
	4			
	5			
	6			
	7			
4	8			
	9			
	10			
	11			
	12			
mean difference				

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TABLE 2-14 ARRAY PERFORMANCE SUMMARY, 290 Hz (U)

deg (dB)

SITE	MEAN BEAMWIDTH DIFFERENCE FROM THEOR		
	16 EL	32EL	MAX APER
1A	0.95° (-.3dB)	0.95° (-0.7dB)	0.6° (-0.6dB)
3	3.36° (-1.6dB)	1.0° (-1.0dB)	3.1° (-3.7dB)
4	0.82° (-0.3dB)	0.1° (-0.1dB)	0.3° (-0.3dB)

(dB)

SITE	MEAN SIGNAL GAIN DIFF. FROM THEOR. (dB)		
	16EL	32EL	MAX APER
1A	-7.2	-6.8	-8.5
3	-0.2	-1.9	-4.0
4	+0.7	+1.5	-0.1

(dB)

SITE	MEAN ARRAY GAIN DIFF FROM THEOR GAZ		
	16EL	32EL	MAX APER
1A	-1.1	-2.1	-4.8
3	+0.6	-1.5	-4.4
4	+0.5	-1.6	-3.2

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TABLE 2-15

ARRAY PERFORMANCE SUMMARY, 140 Hz (U)

deg (dB)

SITE	MEAN BEAMWIDTH DIFFERENCE FROM THEOR		
	16EL	32EL	MAX APER
1A	-	-	-
3	1.68° (-0.4dB)	+2.0° (-1dB)	+2.6° (-1.9dB)
4	-0.1° (0dB)	+1.8° (-0.6dB)	-2.4° (-1.2dB)

(dB)

SITE	MEAN SIGNAL GAIN DIFF. FROM THEOR (dB)		
	16EL	32EL	MAX APER
1A	-	-	-
3	2.2	0.6	-0.8
4	3.8	3.1	0.9

(dB)

SITE	MEAN ARRAY GAIN DIFF FROM THEOR GAZ		
	16EL	32EL	MAX APER
1A	-	-	-
3	3.4	-0.2	-1.4
4	-1.3	-0.9	-3.0

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TABLE 2-16 ARRAY PERFORMANCE SUMMARY, 295 Hz (U)

SITE	MEAN BEAMWIDTH DIFFERENCE FROM THEOR		
	16EL	32EL	MAX APER
1A	4.0° (-1.1dB)	3.0° (-1.8dB)	0.4° (-.5dB)
3			
4			

SITE	SIGNAL GAIN DIFF. FROM THEOR (dB)		
	16EL	32EL	MAX APER
1A	-11.1	-12.1	-15.5
3			
4			

SITE	ARRAY GAIN DIFF. FROM THEOR GAZ		
	16EL	32EL	MAX APER
1A	-4.4	-6.6	-11.2
3			
4			

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2.6(C) ARRAY PERFORMANCE AT 295 Hz (U)

(C) Only a limited and somewhat dubious data base (2 data points) for array gain is reported for the 295 Hz line. (see Table 2-17) Because the low 295 Hz signal levels radiated were detected on omni channels only in Site 1A (DP 1 and 2), array gain is reported only for these data points. The beam-formed array output, however, indicated detections of the 295 Hz line in all three sites.

(C) Comparison of 290 and 295 Hz measured signal levels on omni channels (Table 2-17) show poor agreement with radiated levels. On the other hand, agreement of beamformed signal level is in good agreement (except for DP 2) with radiated levels. Further, one observes that measured SNR values for beamformed data are quite small (2.5 to 3.2 dB) in the analysis bandwidth for DP 1 and 2, making it implausible that the omni SNR's reported are accurate. The conclusion drawn is that measured omni signal levels are suspect, and the resulting SNR and AG values in Table 2-17, and in other data presented is questionable.

(C) It is noted from Table 2-17 that the AG for data points 8 and 9 must exceed 9.7 and 11.7 dB respectively, since presumably the omni SNR for these points is zero dB or less.

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TABLE 2-17
 COMPARISON OF SIGNAL LEVELS, SNR AND AG FOR 295 HZ DATA (U)

Site	DP	Range	Proj Signal		Δ Sig Level (dB)	Meas		Omni Δ Sig Level (dB)	Meas BF		BF Δ Sig Level (dB)	Meas SNR @ 295 Hz		AG @ 295 Hz (dB)
			Level (dBuPa)	295Hz		Sig Level (dBV)	295Hz		Level (dBV)	295Hz		BF (dB)	Omni (dB)	
1A	1	91	155	145	-10	-49.7	-53.3	-3.6	-27.6	-36.3	-8.7	2.5	-2.0	4.5
	2	91	155	140	-15	-51.5	-51.2	+0.2	-24.2	-31.4	-7.2	3.2	-0.7	3.9
3	7	28	180	143	-37	-17.5	*	*	12.0	-24.2	-36.2	3.3	*	*
	8	22	182	143	-39	-15.2	*	*	16.8	-19.2	-36.0	9.7	*	*
9	72		182	143	-39	-12.5	*	*	20.4	-17.8	-38.2	11.7	*	*
	(1) These are in good agreement with projected signal levels.													
(2) These are in poor agreement with projected signal levels.														
* Signal not detected on individual omni channels. Therefore, SNR and AG cannot be computed from measured data.														
CONCLUSION: Omni measured signal levels and, therefore, SNR's are questionable and thus the very low measured array gain (AG) values reported (3) are unreliable.														

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Appendix A

Comaprison of Signal Gain & Array Gain Vs. Number
of Elements (U)

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FIG. A-1:

COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS

MEASURED AT

250 MHz (20)

DP1

1-14-77

15512

SIGNAL GAIN

30 LOG N

140 dB REFERENCE

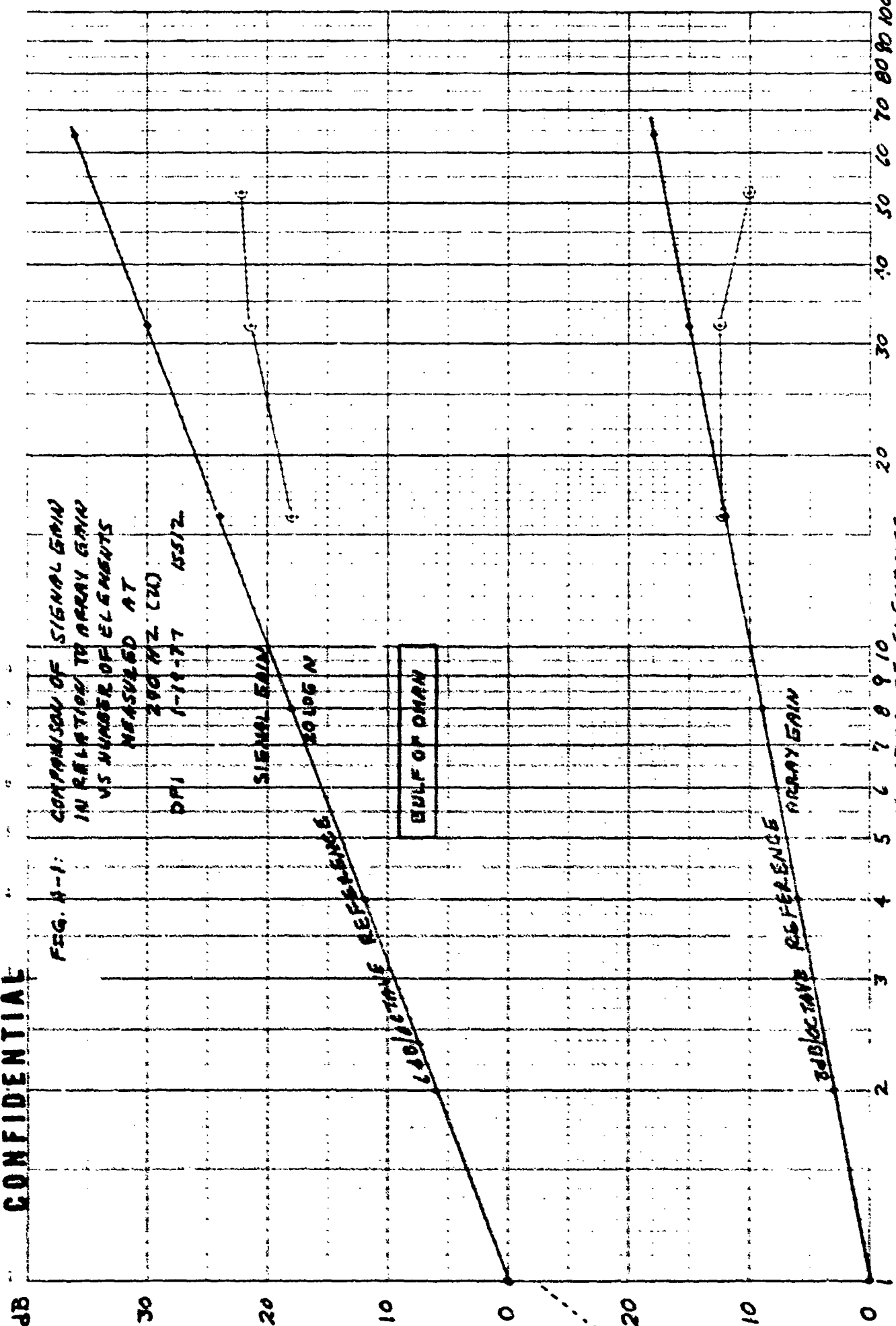
BULK OF DATA

30 LOG N REFERENCE

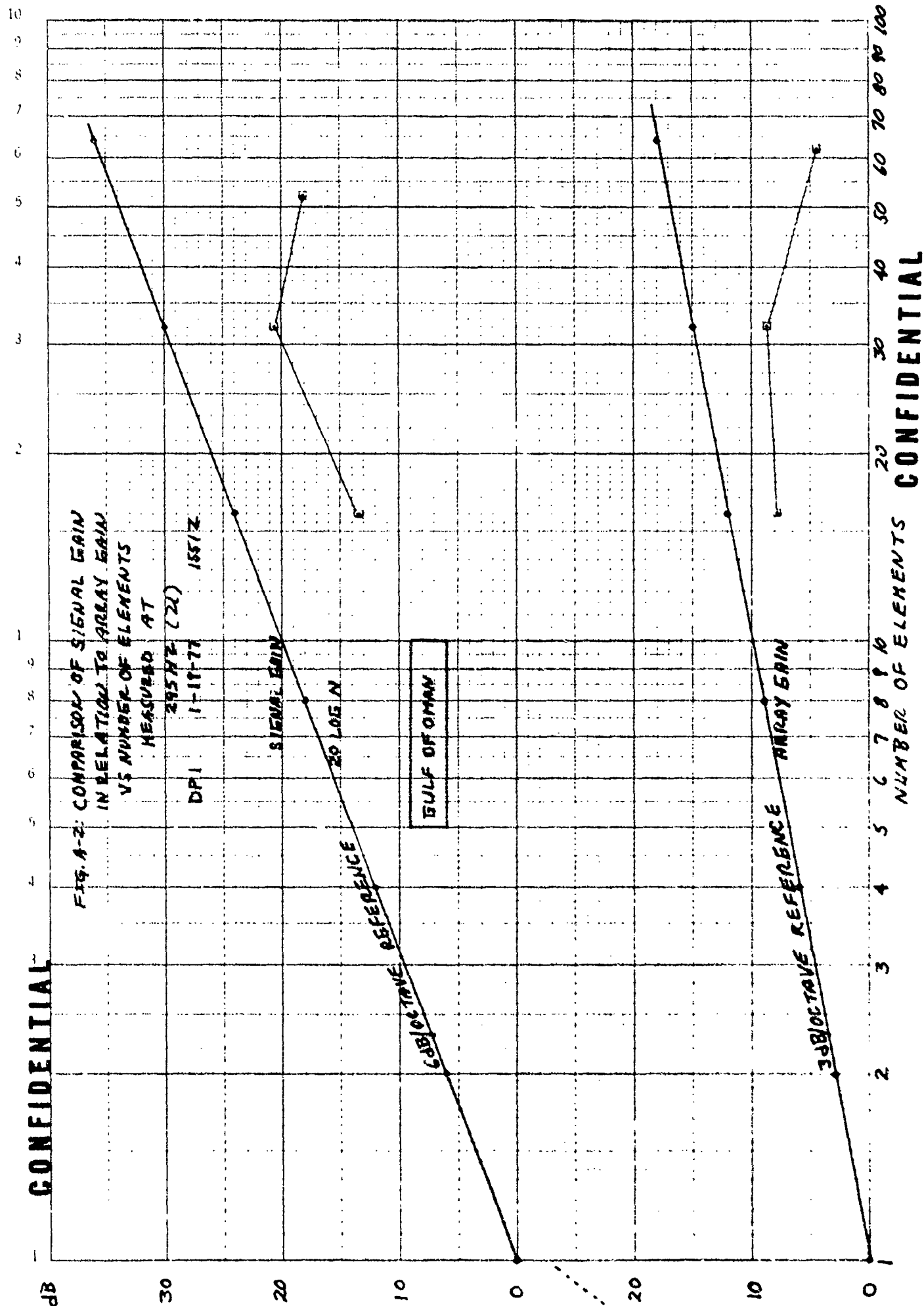
ARRAY GAIN

NUMBER OF ELEMENTS

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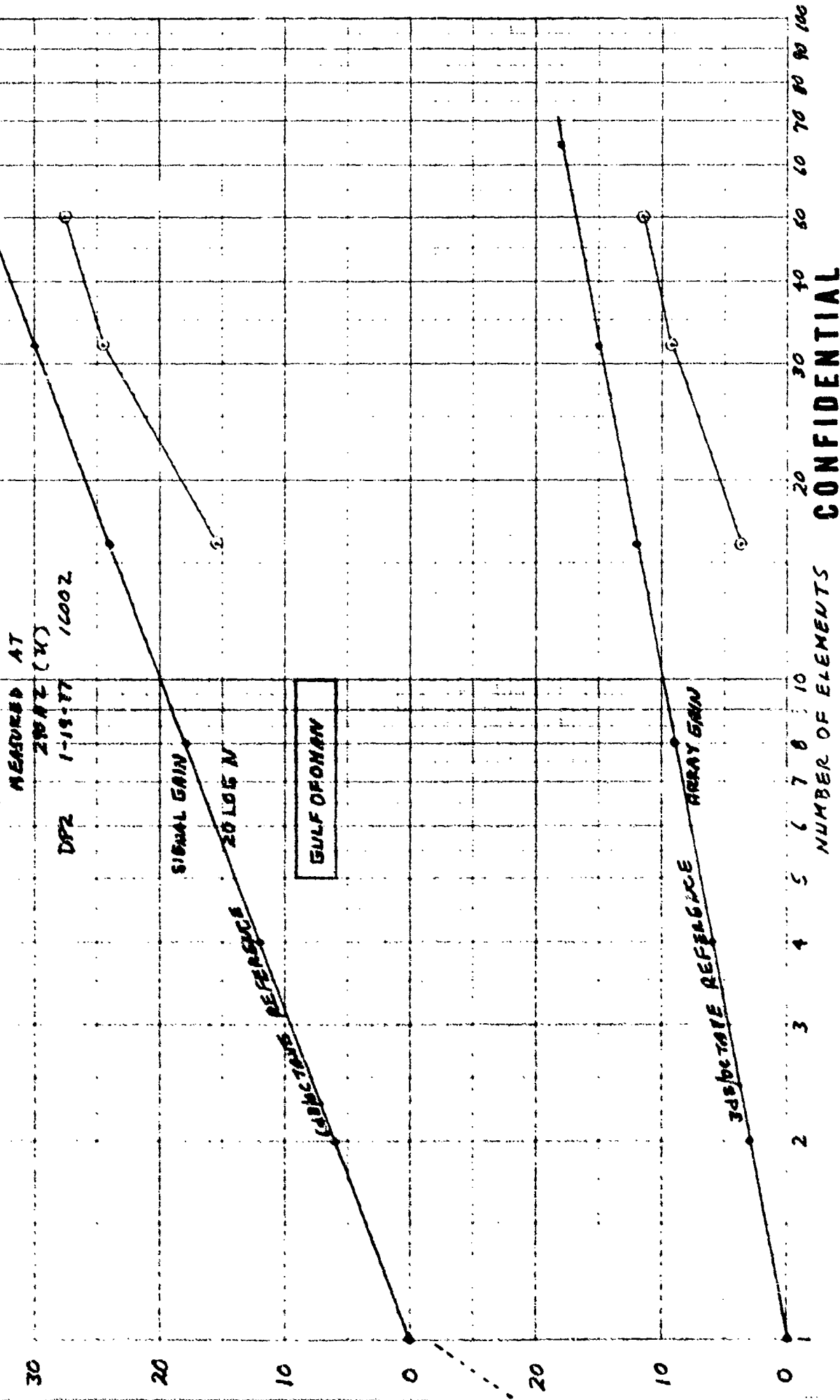


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FIG. A-3: COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS



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FILE # 46 4973

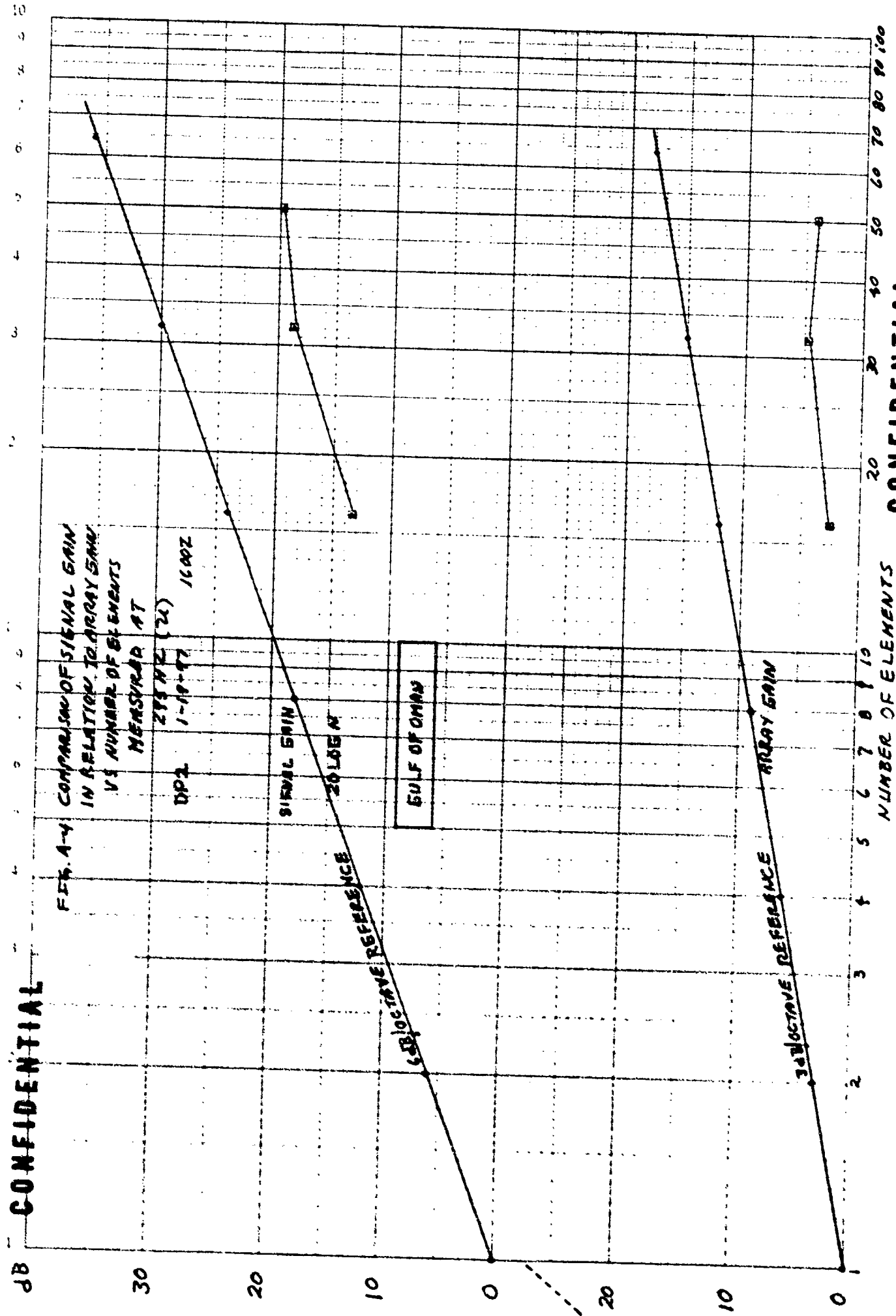
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FIG. A-4: COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS. NUMBER OF ELEMENTS
MEASURED AT

DP2 275 HZ (24) 1600Z
1-19-77

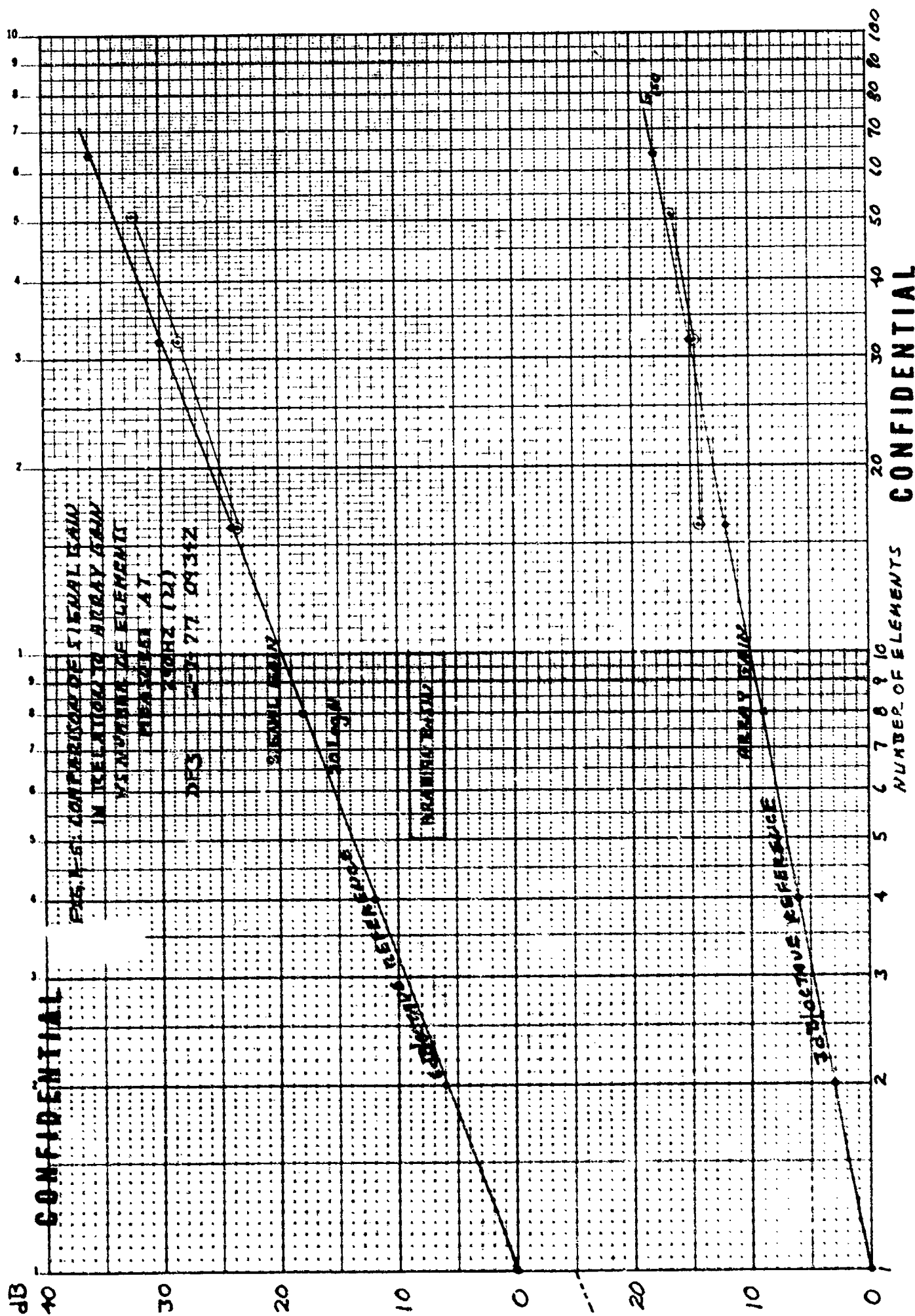
SIGNAL GAIN
20 DB

GULF OF OMAN

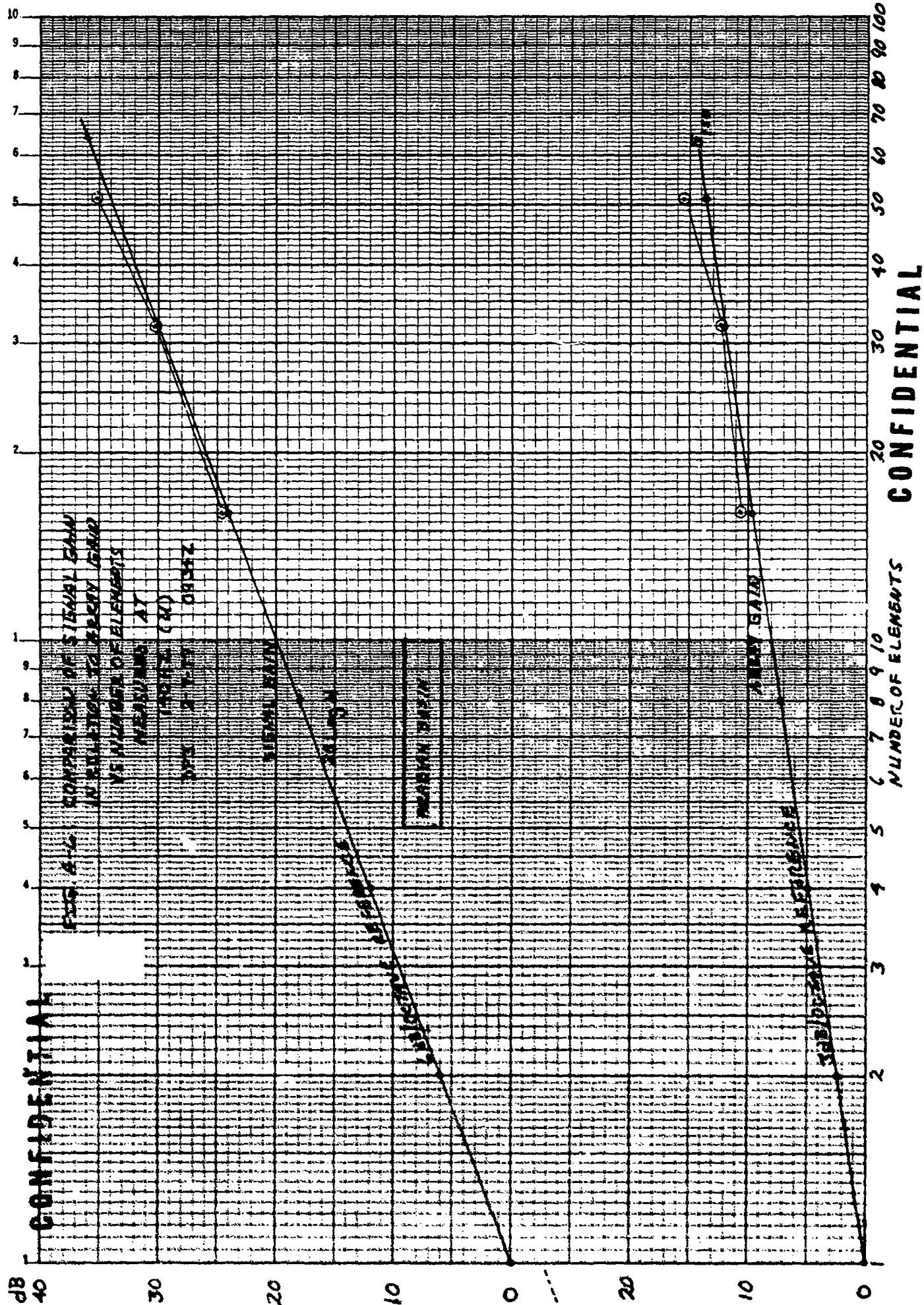


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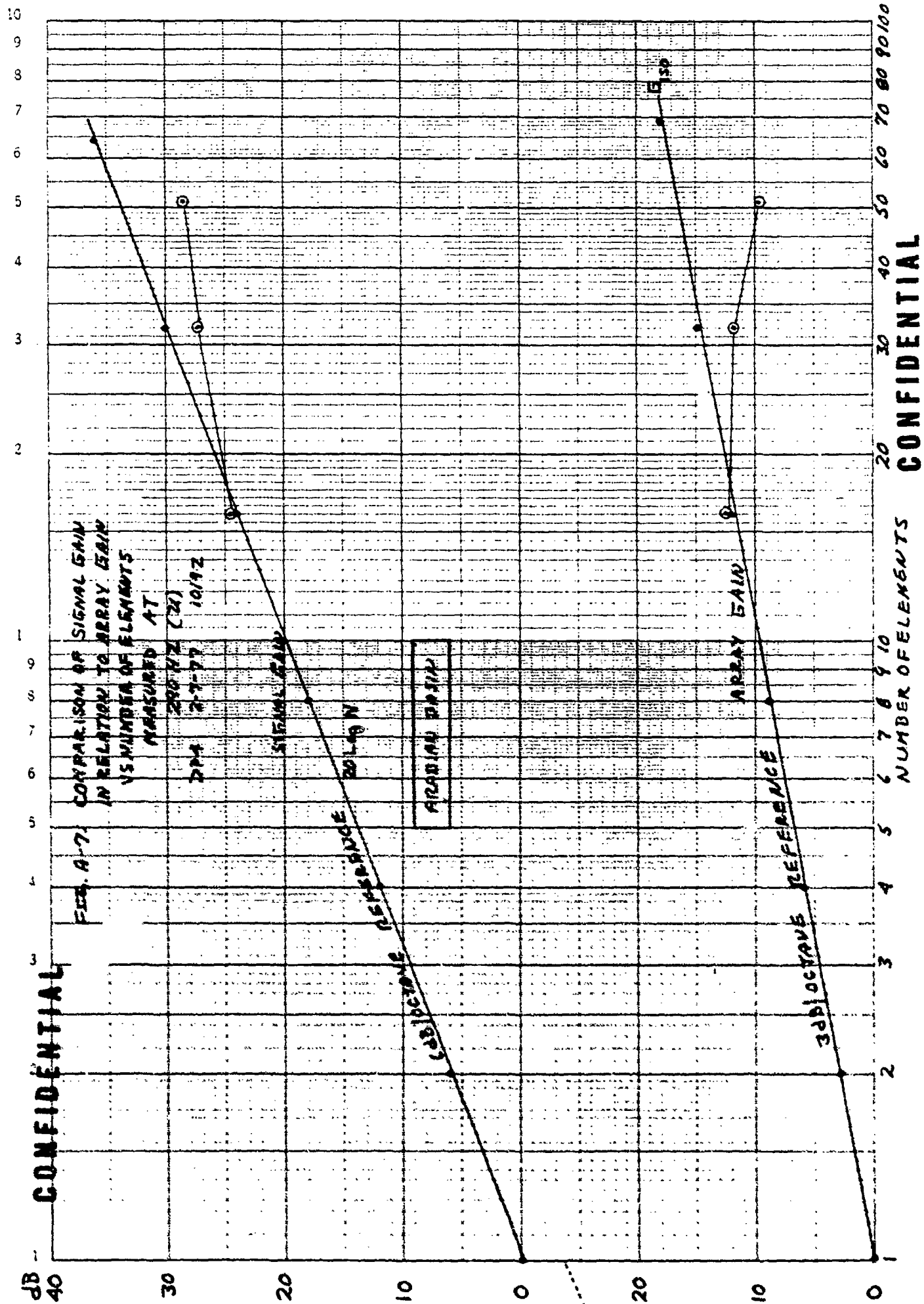
REF ID: A681073
 1 CYCLES PER DIVISION
 REUPPEL & GROSS CO

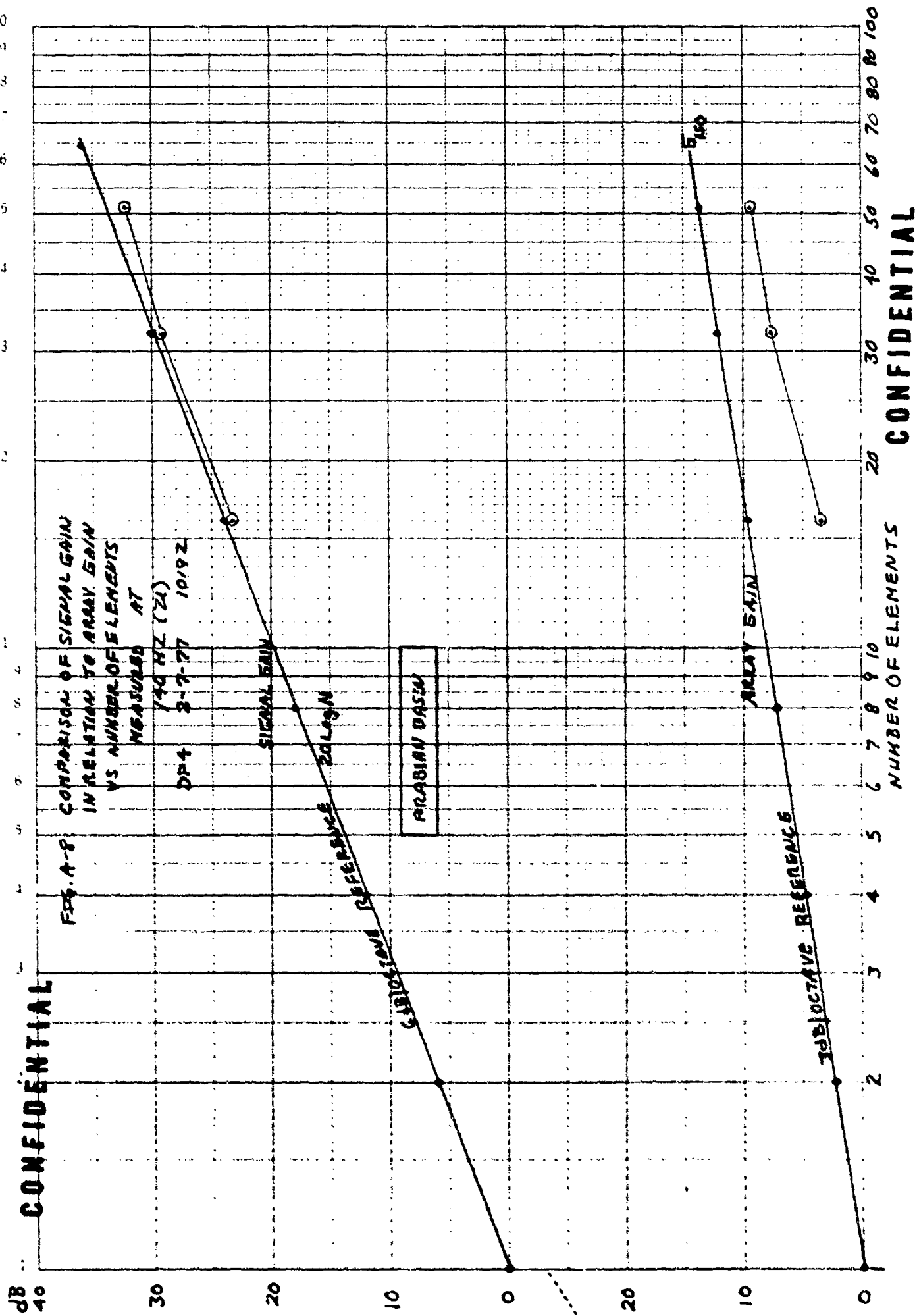


KOE SEMILOGAR-TIME/IN 20-4073
2 CYCLES A MINUTE
REUFFEL & COBB CO



46 4973





CONFIDENTIAL

FIG. A-9: COMPARISON OF SIGNAL GAIN IN RELATION TO ARRAY GAIN VS NUMBER OF ELEMENTS MEASURED AT

280HZ (24)
DPS 2-7-77 1549Z

SIGNAL GAIN

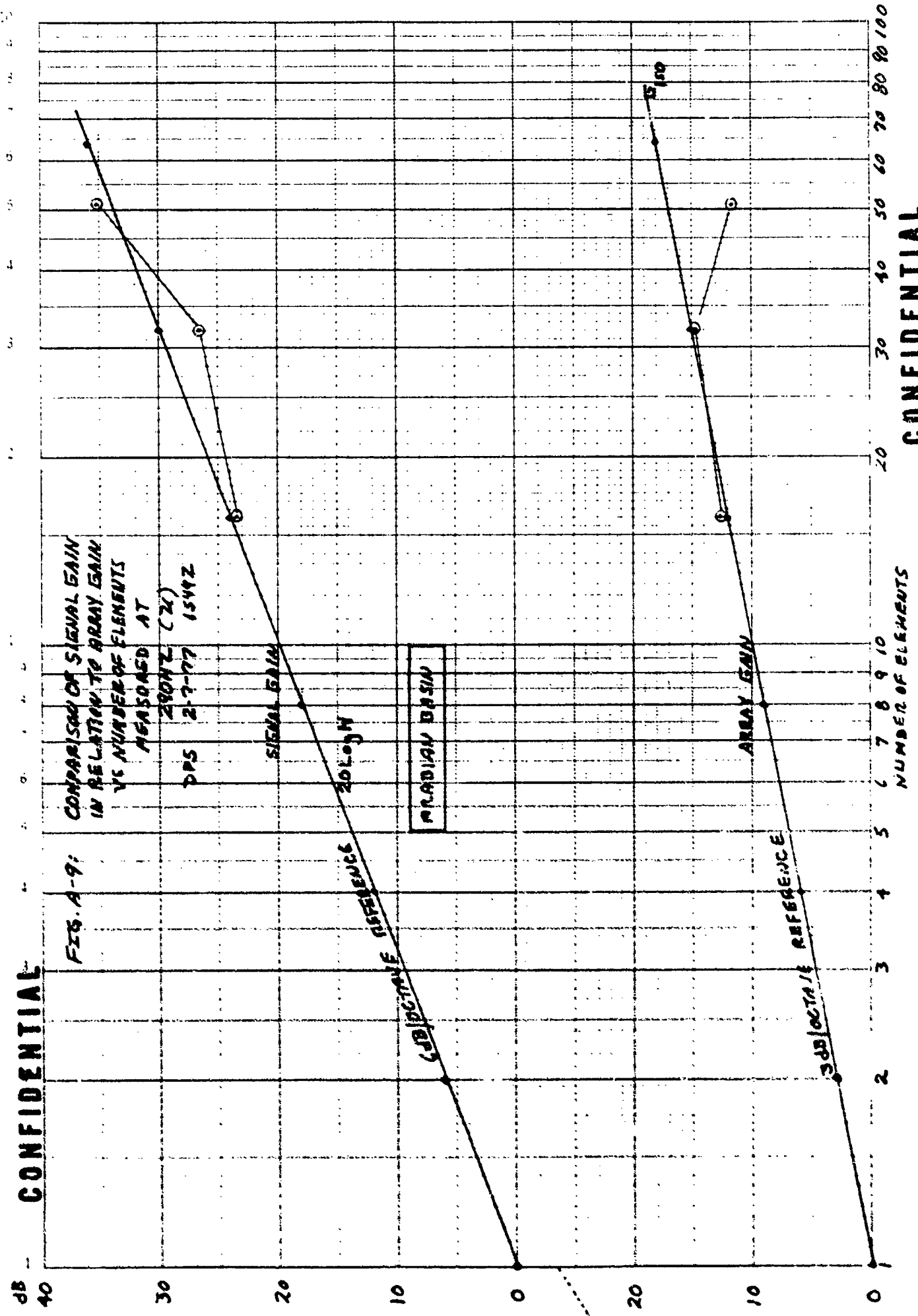
20LOG N

ARRAY GAIN

ARRAY GAIN

3dB/OCTAVE REFERENCE

6dB/OCTAVE REFERENCE



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FILE A-10:

COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS
MEASURED AT

DPS	140 WZ	(74)	1549Z
	27-77		

五、

76

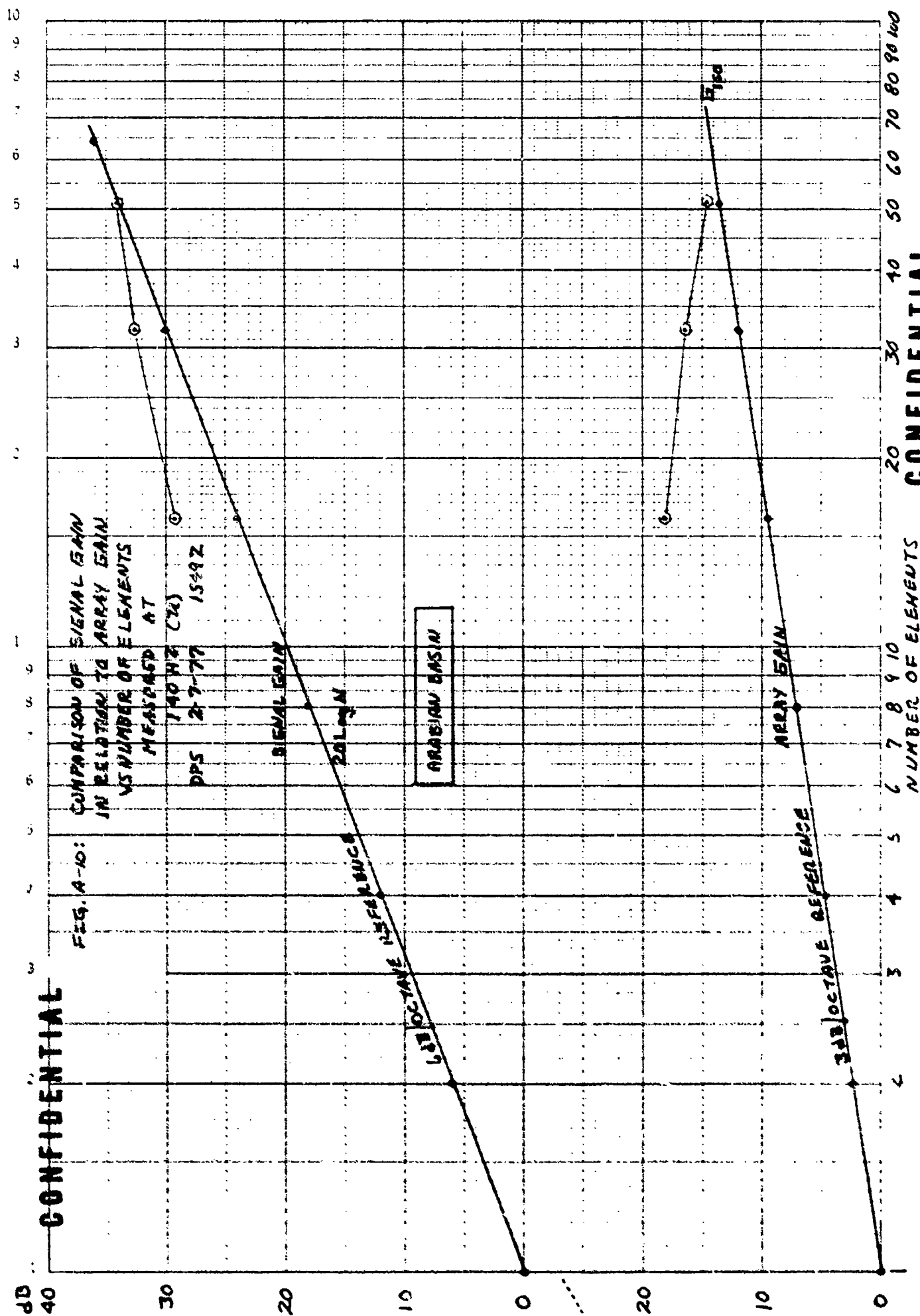
ARABIAN BASIN

1.17 OCTAVE 125

REFERENCE

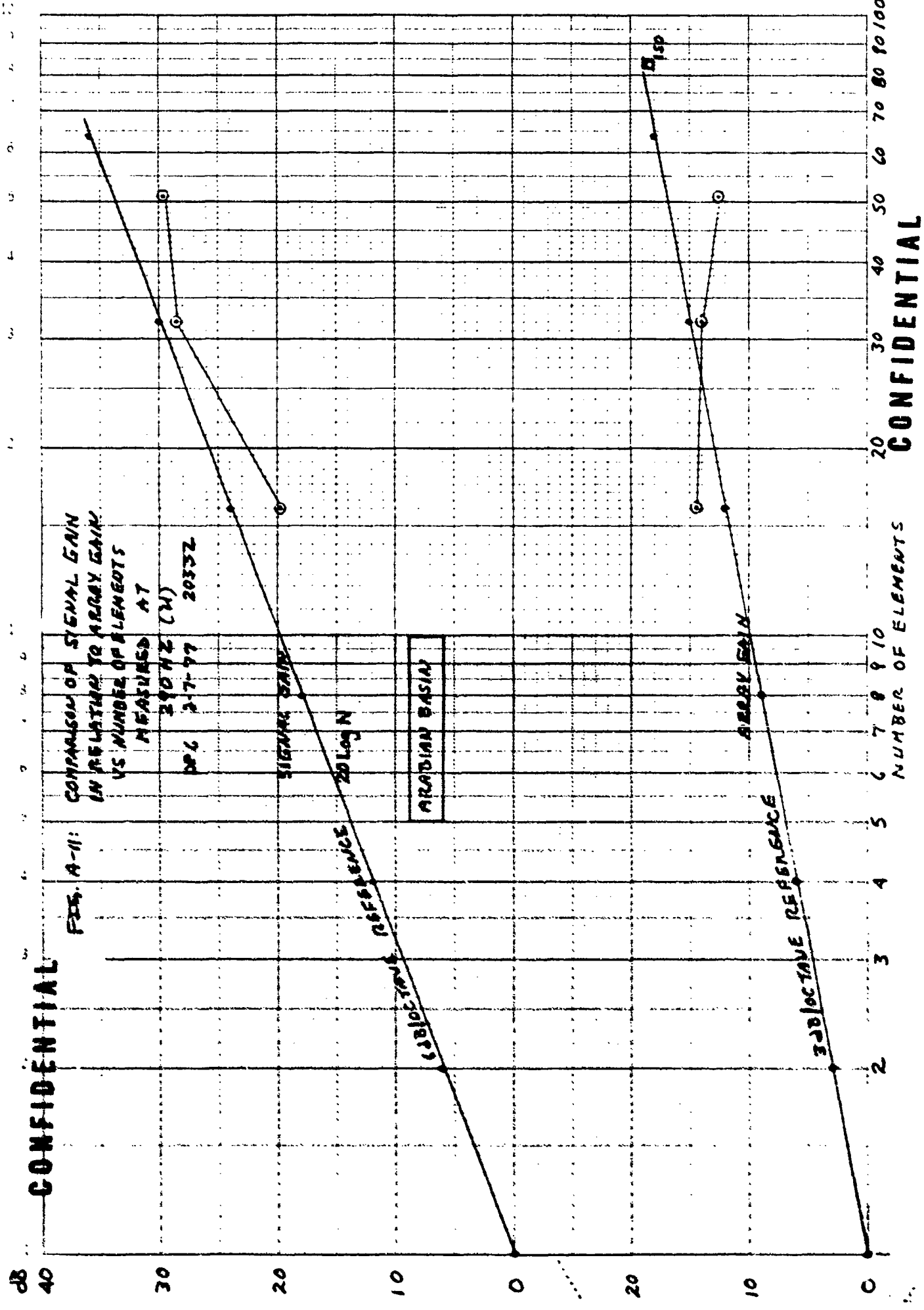
MEYER BAY

57



NUMBER OF ELEMENTS

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46 4973

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FIG. A-12: COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS
MEASURED AT

140 MHz (M)
DPL 2-7-77 20332

SIGNAL GAIN

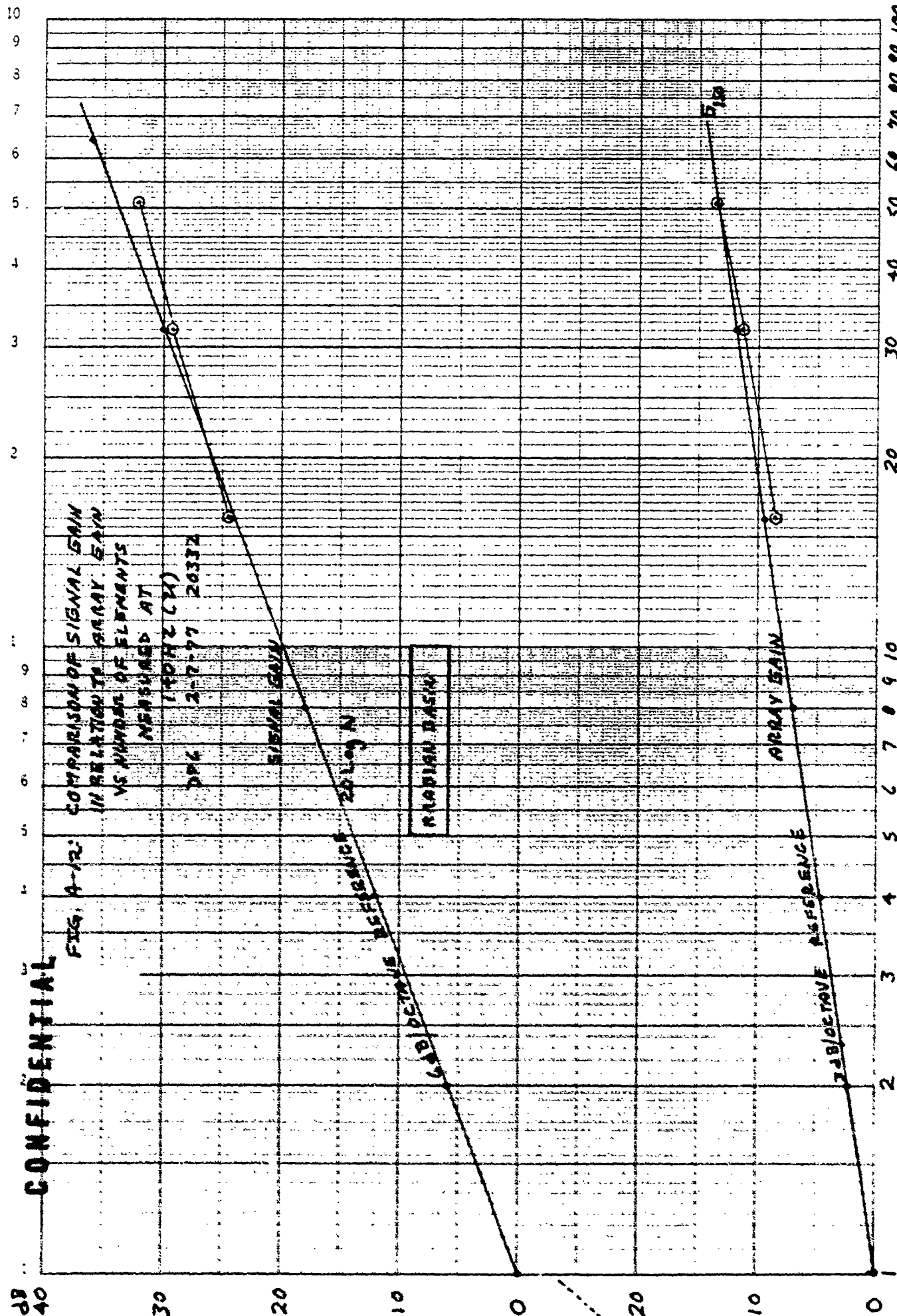
20 Log N

RADIANT GAIN

ARRAY GAIN

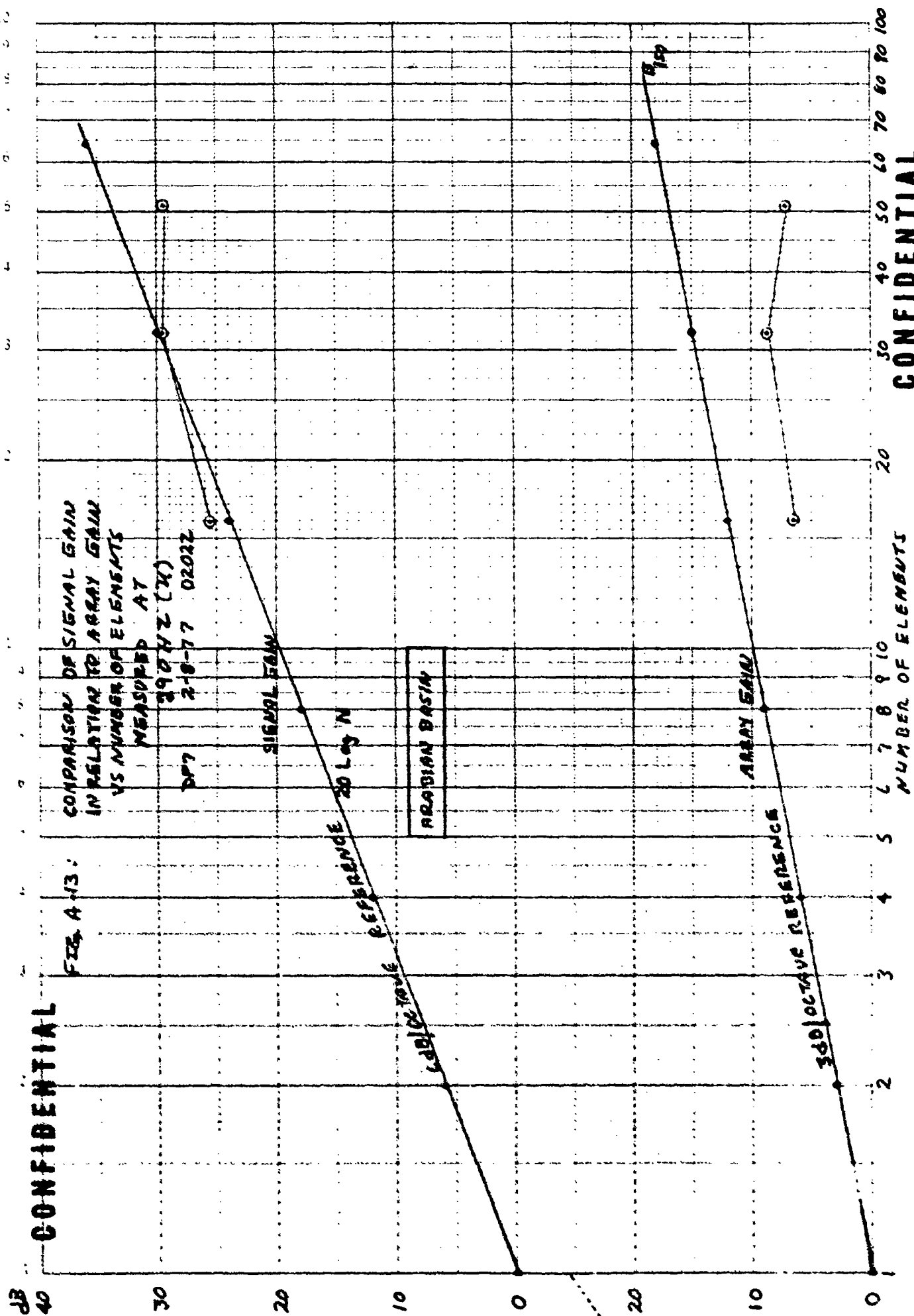
3 dB/OCTAVE REFERENCE

3 dB/OCTAVE REFERENCE



NUMBER OF ELEMENTS

CONFIDENTIAL



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FIG. A-14: COMPARISON OF SIGNAL GAIN IN RELATION TO ARRAY GAIN VS NUMBER OF ELEMENTS MEASURED AT

DP7 140 NZ (20)
2-9-77 020220

SIGNAL GAIN

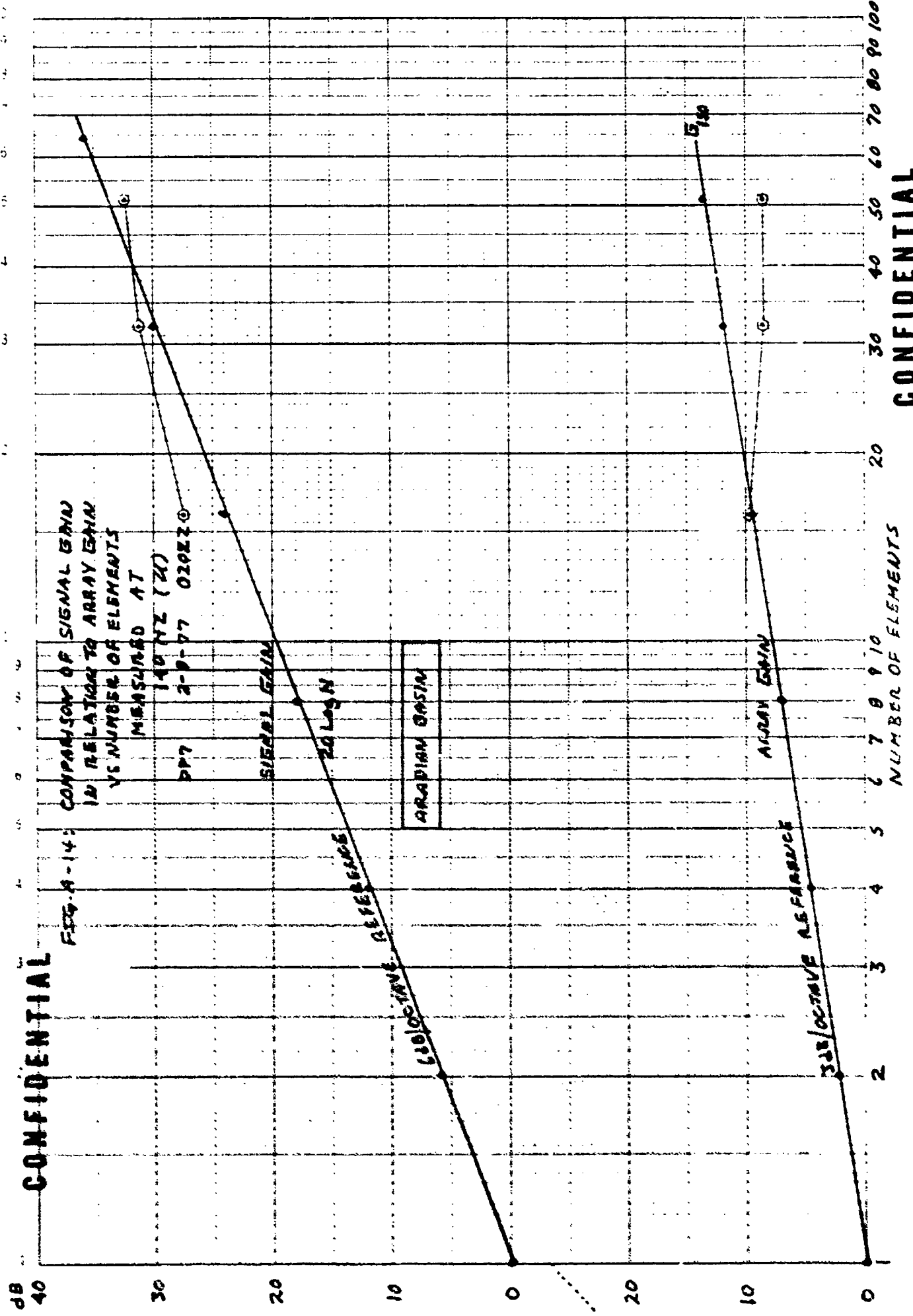
20 LOG N

ARADIAN GAIN

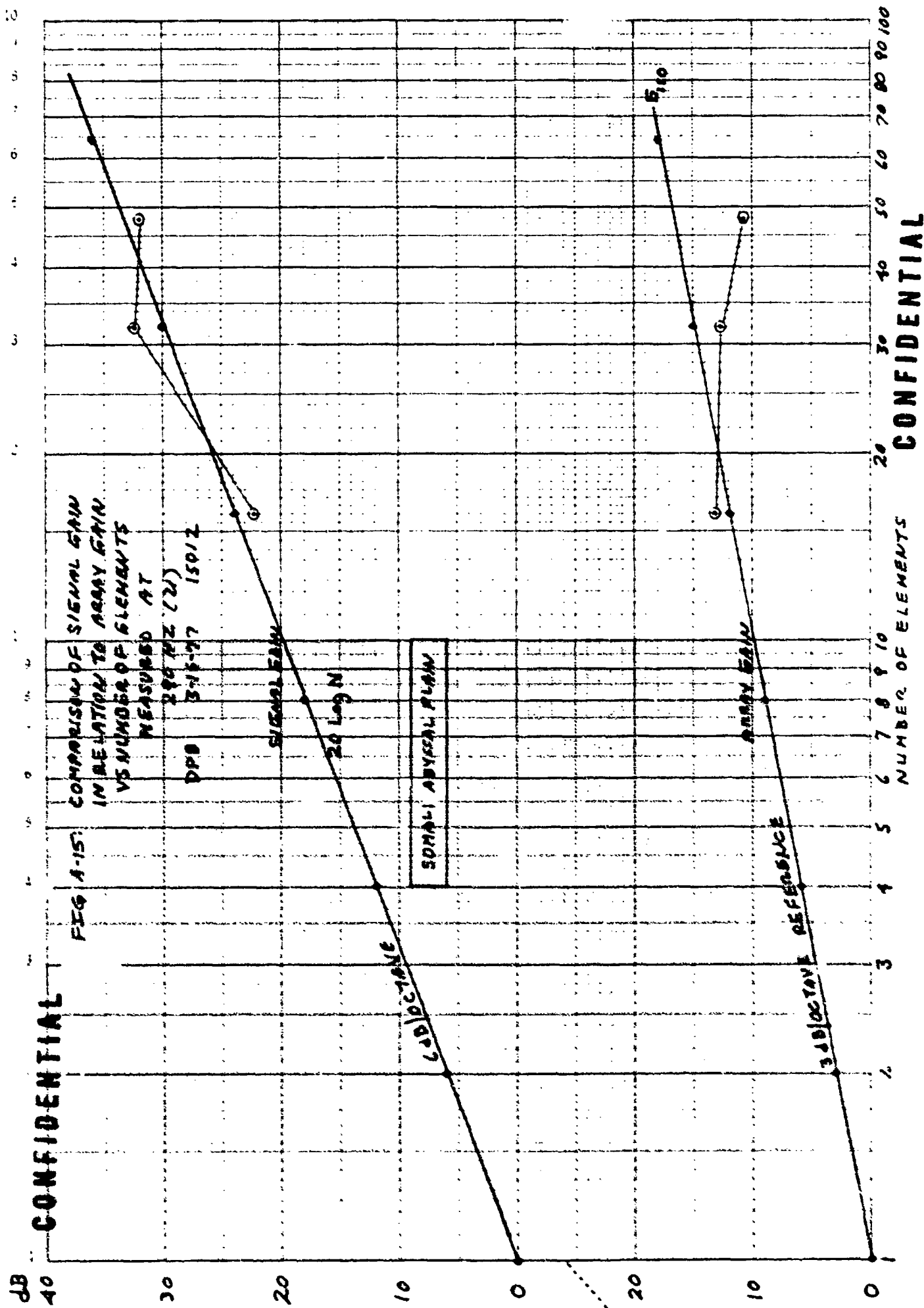
110/OCTAVE REFERENCE

ARRAY GAIN

3.15/OCTAVE AS FARRADICE



CONFIDENTIAL



CONFIDENTIAL

dB

FIG. A-16: COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS
MEASURED AT

140HZ (24)
DPB 3-15-77 15012

SIGNAL GAIN

20log N

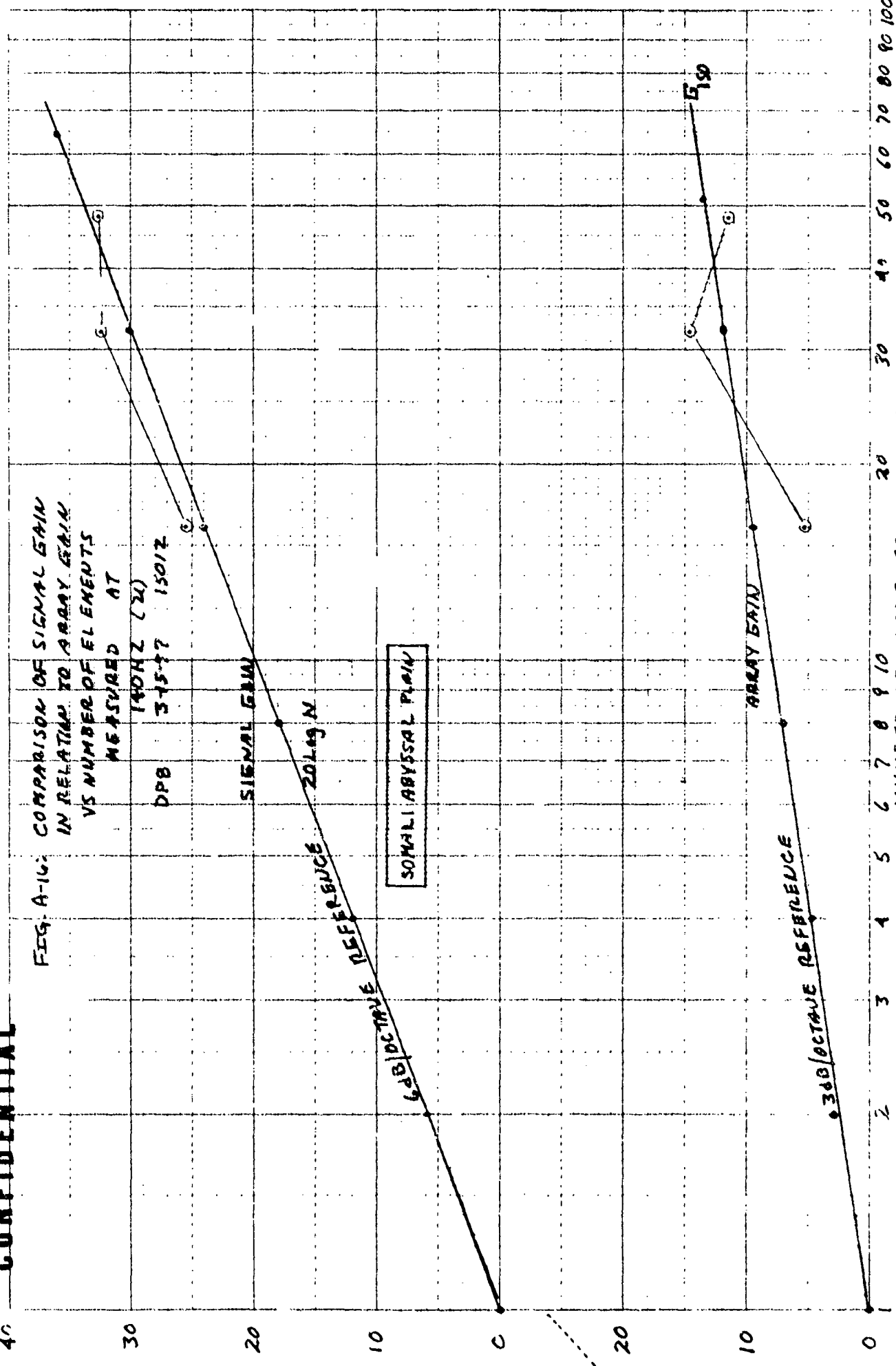
SOMALI ABYSSAL PLAIN

ARRAY GAIN

3dB/OCTAVE REFERENCE

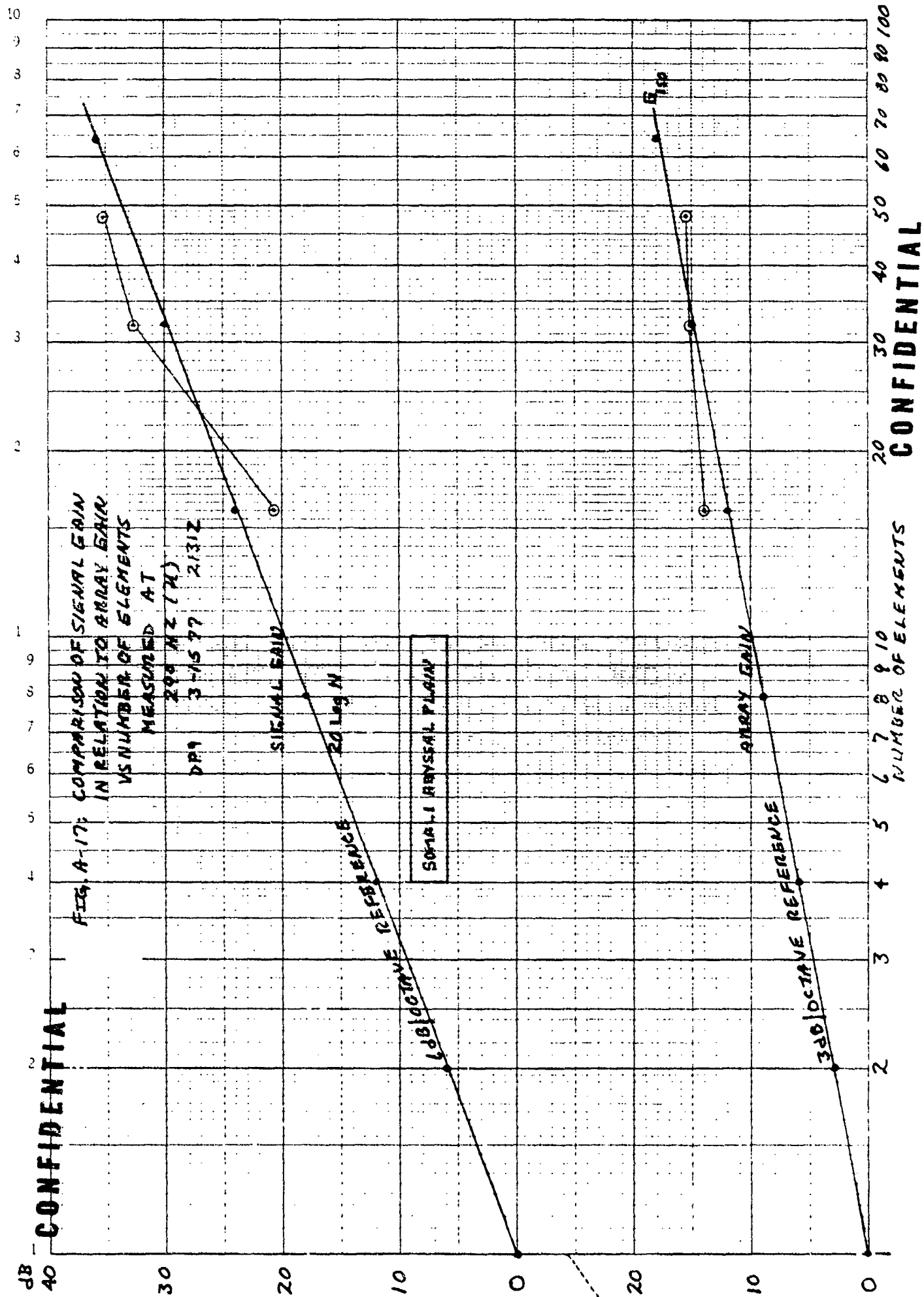
NUMBER OF ELEMENTS

CONFIDENTIAL

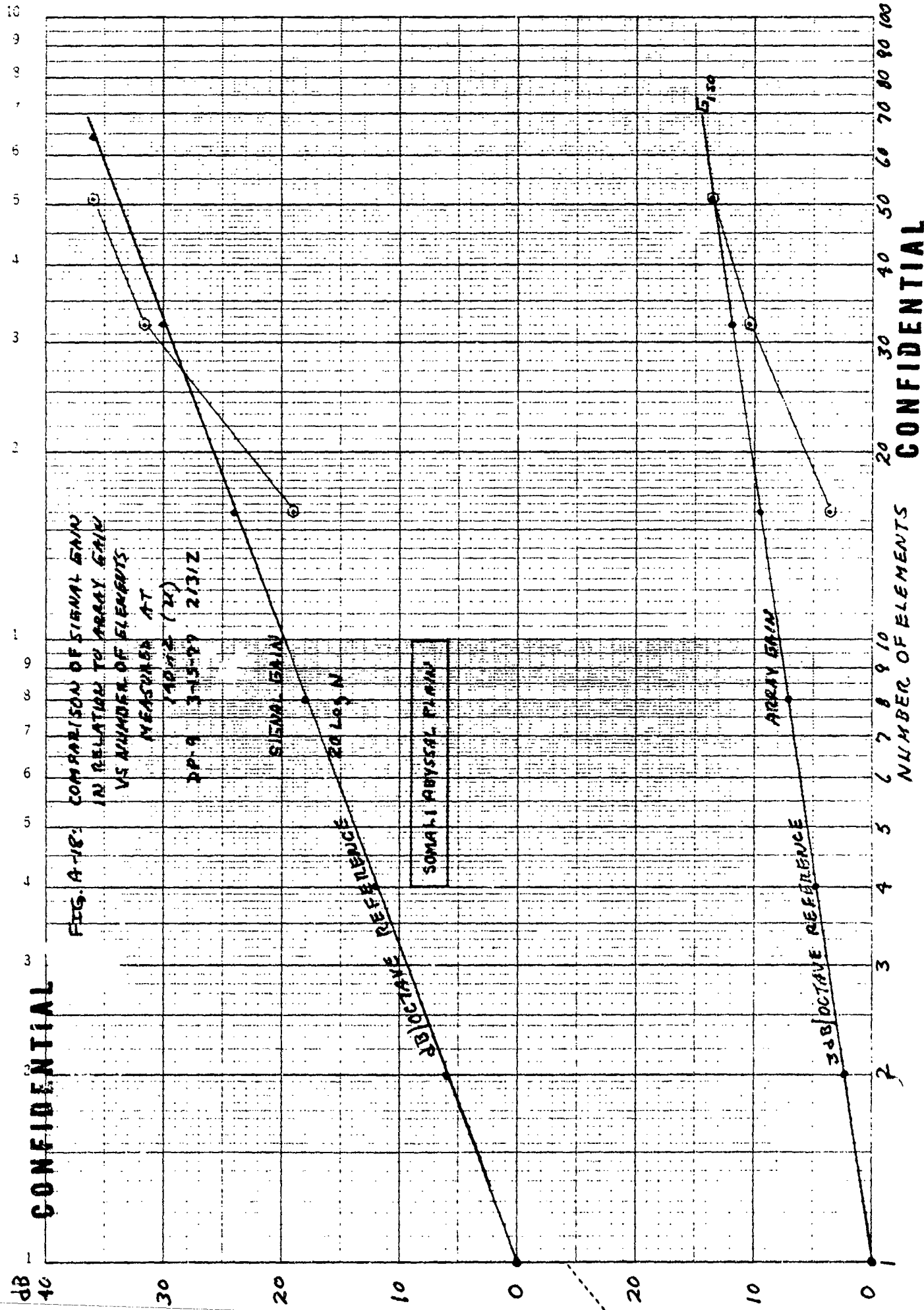


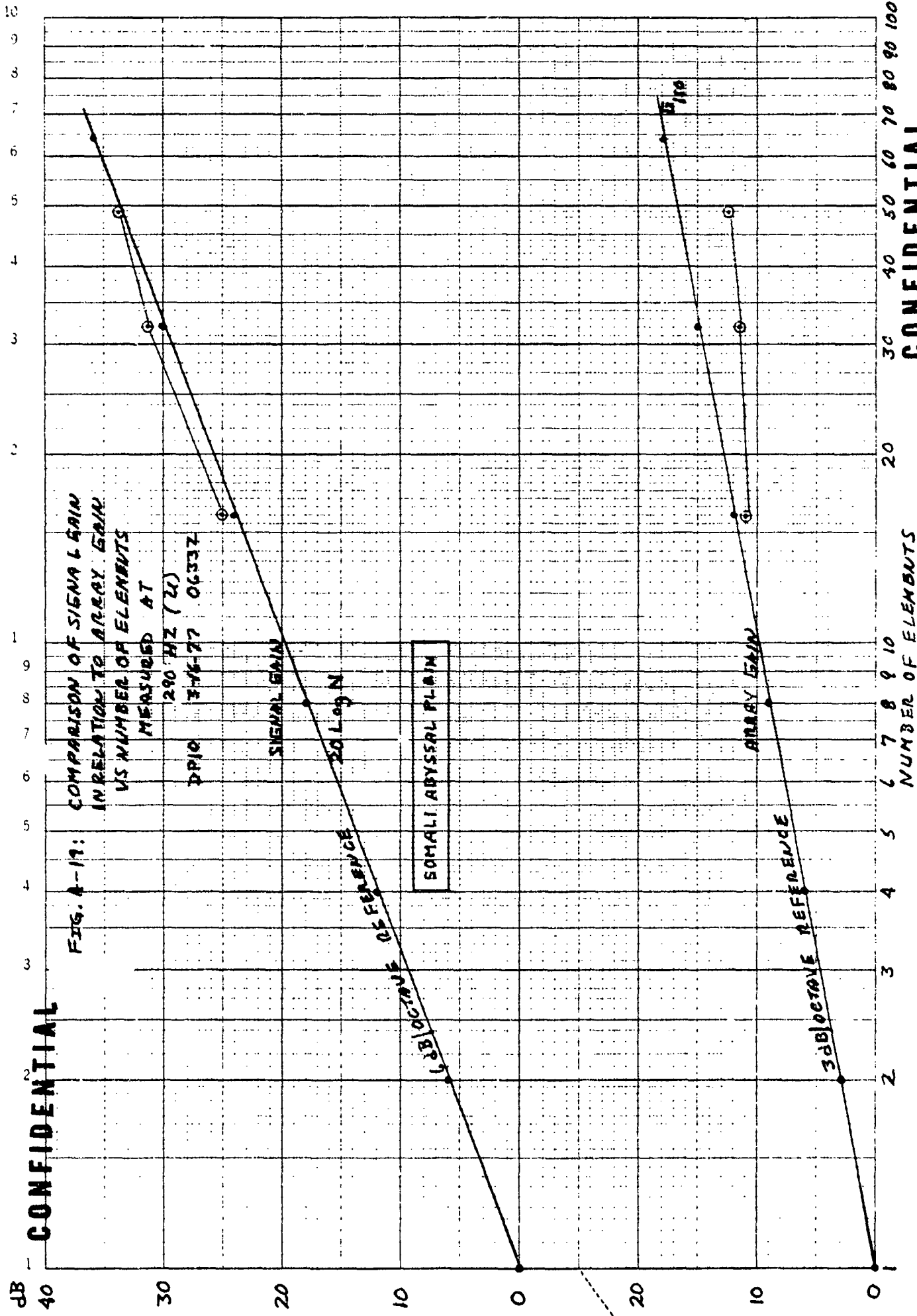
40 49/3

R-2 SEMI-2 PTHD. CASE 60 100



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FIG. A-20: COMPARISON OF SIGNAL GAIN IN RESOLUTION TO ARRAY GAIN VS NUMBER OF ELEMENTS MEASURED AT

1400HZ (21)
DPM 344-47 0633Z

SIGNAL GAIN

20 LOG N

SOMALI ABYSSAL PLAIN

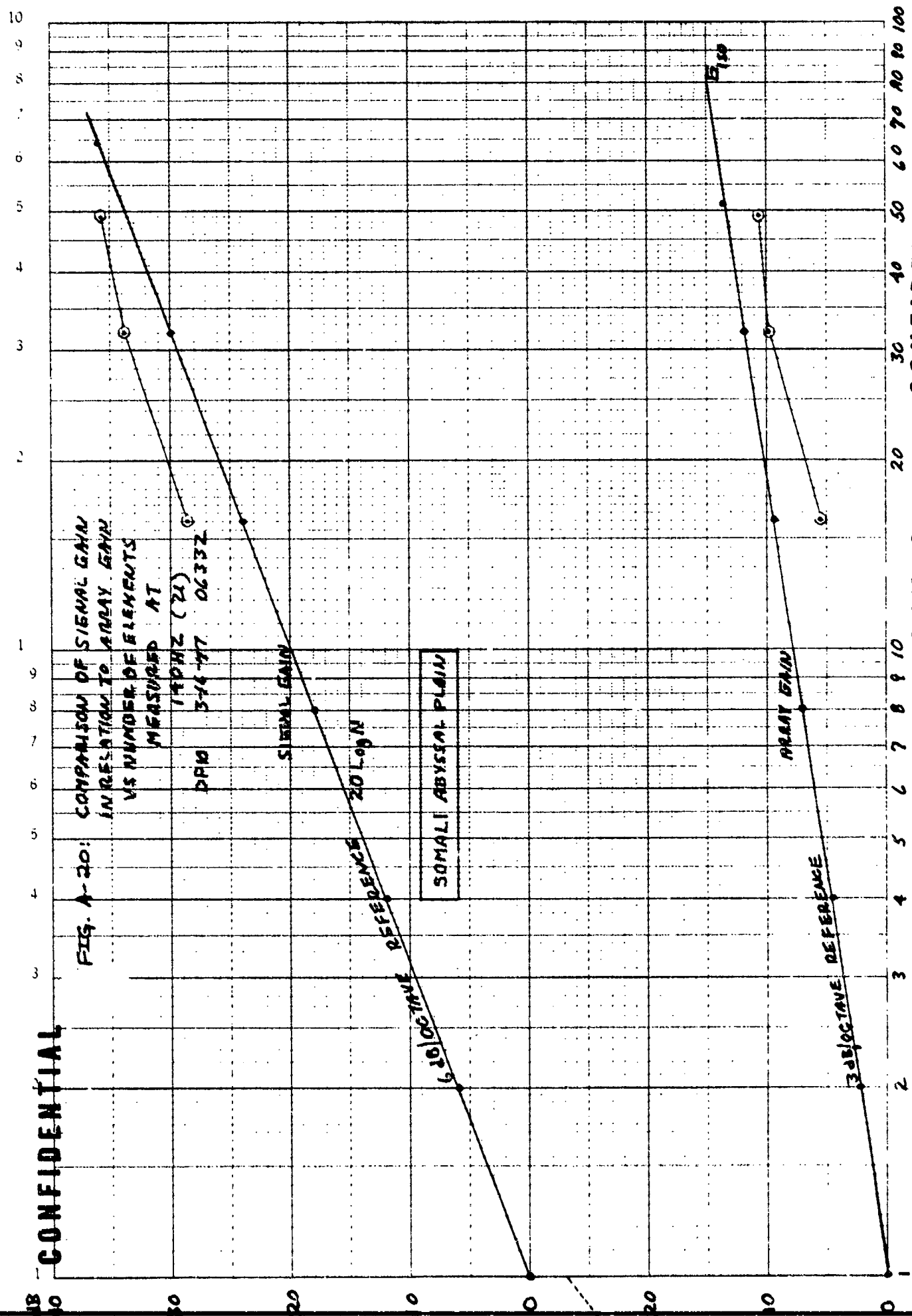
ARRAY GAIN

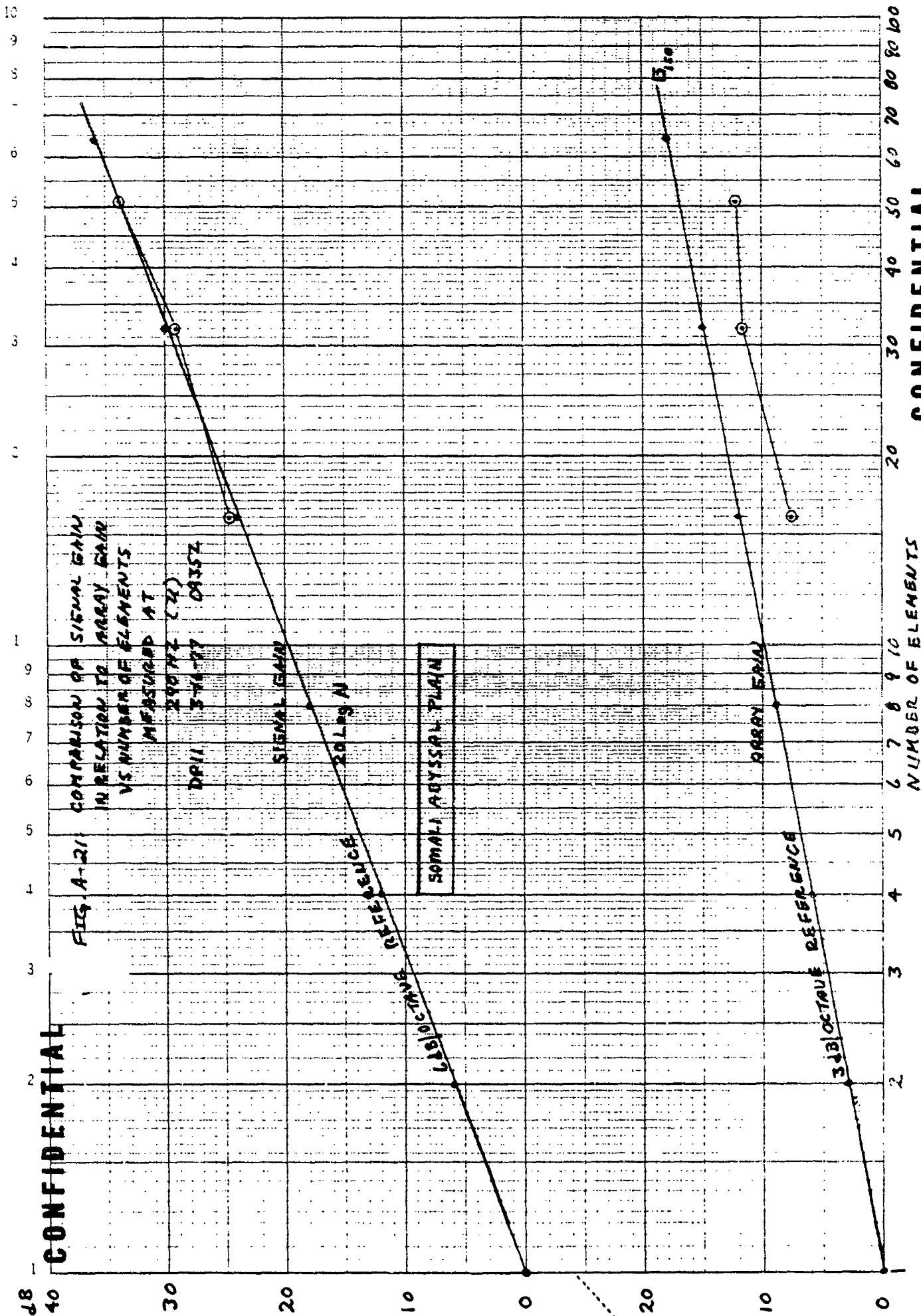
3dB/OCTAVE REFERENCE

6dB/OCTAVE REFERENCE

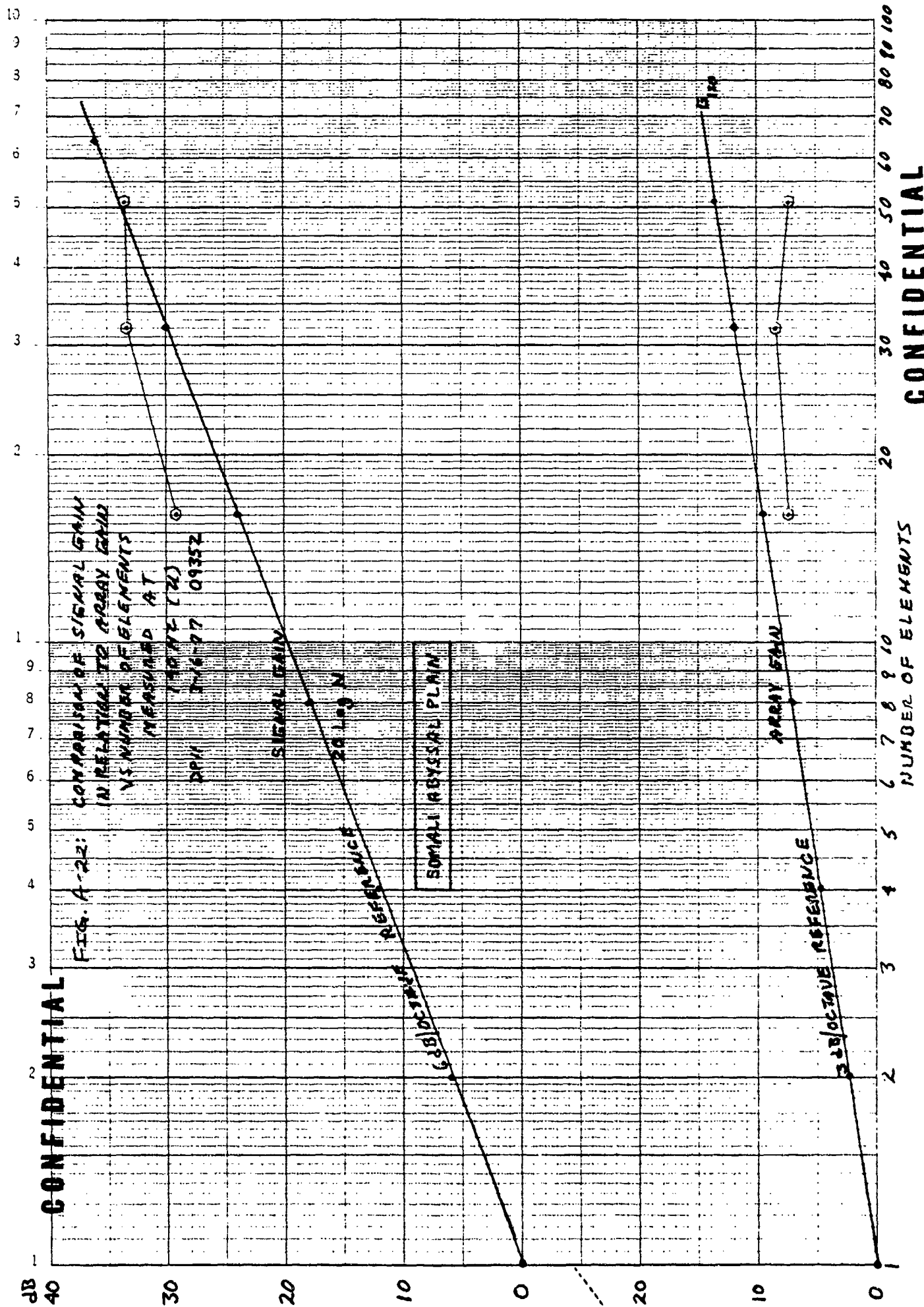
NUMBER OF ELEMENTS

CONFIDENTIAL





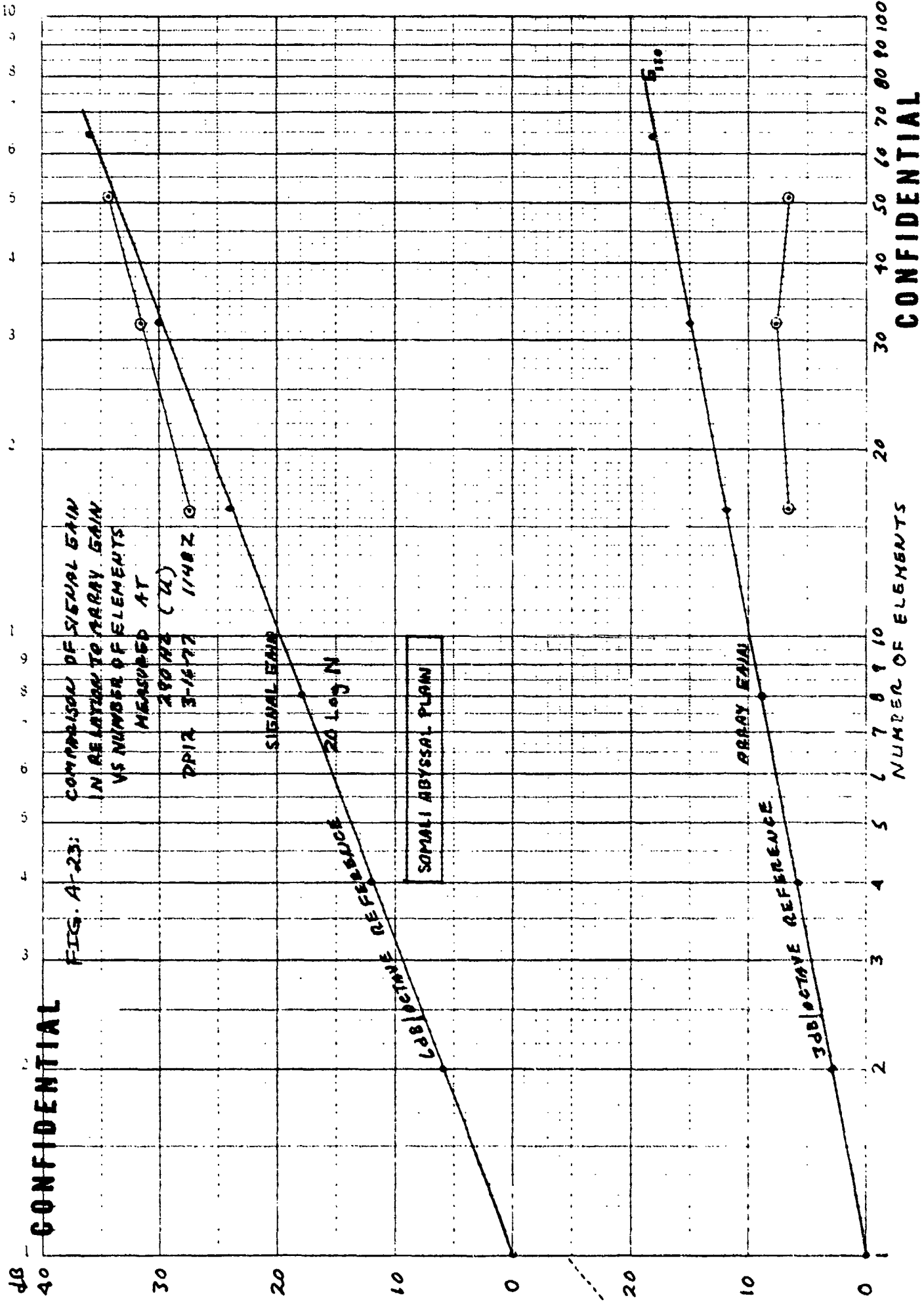
CONFIDENTIAL



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49,0

FIG. A-23: COMPARISON OF SIGNAL GAIN IN RELATION TO ARRAY GAIN VS NUMBER OF ELEMENTS MEASURED AT



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FIG. A-24:

COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS
MEASURED AT

740 HZ (22)
DPIZ 3-16-77 1140Z

SIGNAL GAIN

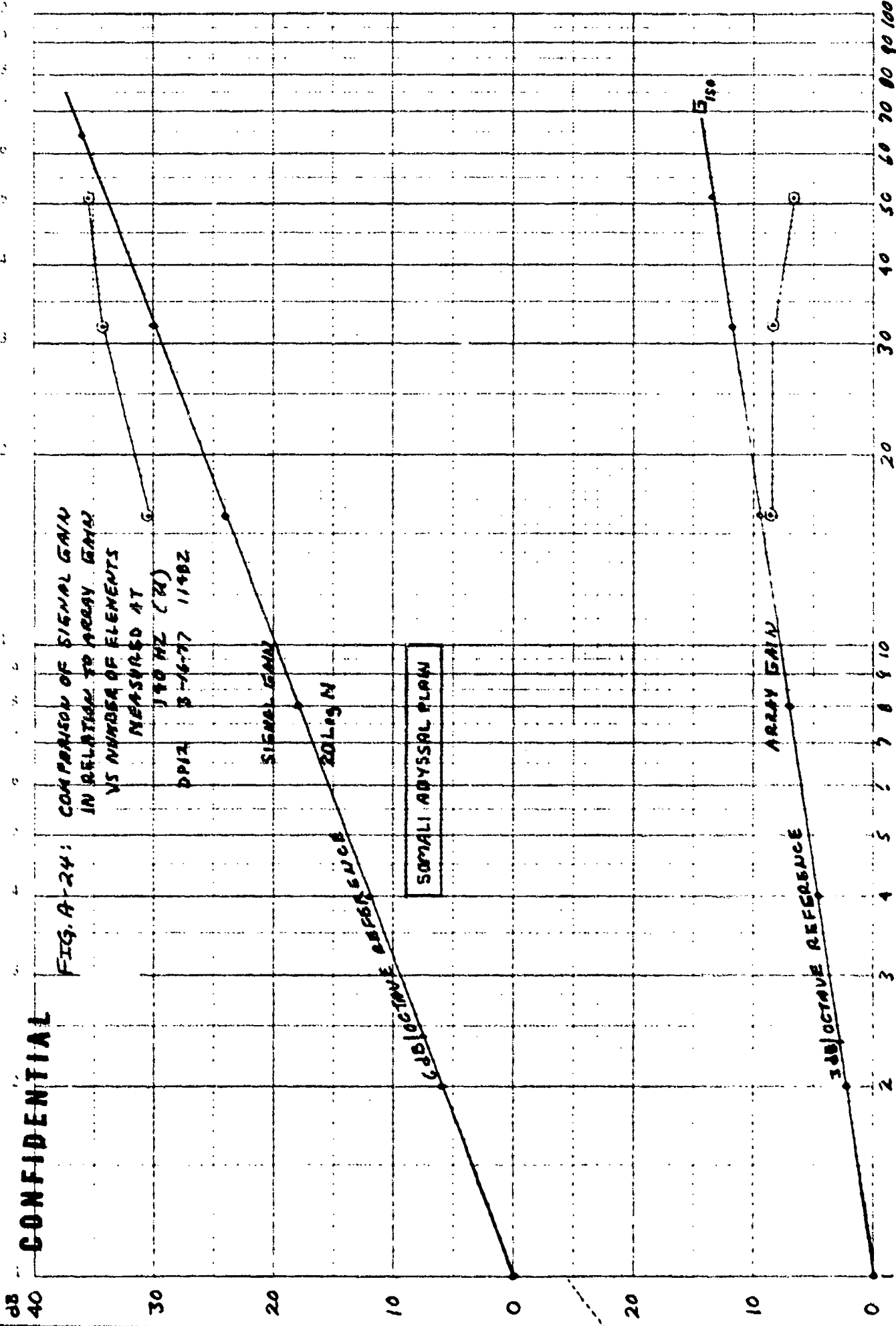
20 LOG N

SOMALI ABYSSAL PLAN

ARRAY GAIN

3dB/OCTAVE REFERENCE

3dB/OCTAVE REFERENCE



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UNCLASSIFIED

**APPENDIX B THEORETICAL BEAM PATTERN &
ARRAY GAIN DATA (U)**

UNCLASSIFIED

51237 SANDERS BEAM PATTERN PROGRAM (T.MORAN) 24-JAN-76 ONTLP 3.1

A: 53 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.

ELEMENT 16 DELETED FROM APERTURE

S: SAME

DATA POINT 1

1200 HZ. SAMPLING FREQ. DEGRADES PATTERN

290.0 HZ. 52 ELEMENTS. -0.03 DB MAX. AC:51543.SU:51543.UT:

90.0 DEG. VERT. RESP. 149.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER

3.85 DEG. 3 DB BEAM. 15.41 DB AZ. GAIN. MAX. AT 149.0 DEG. HORIZ.

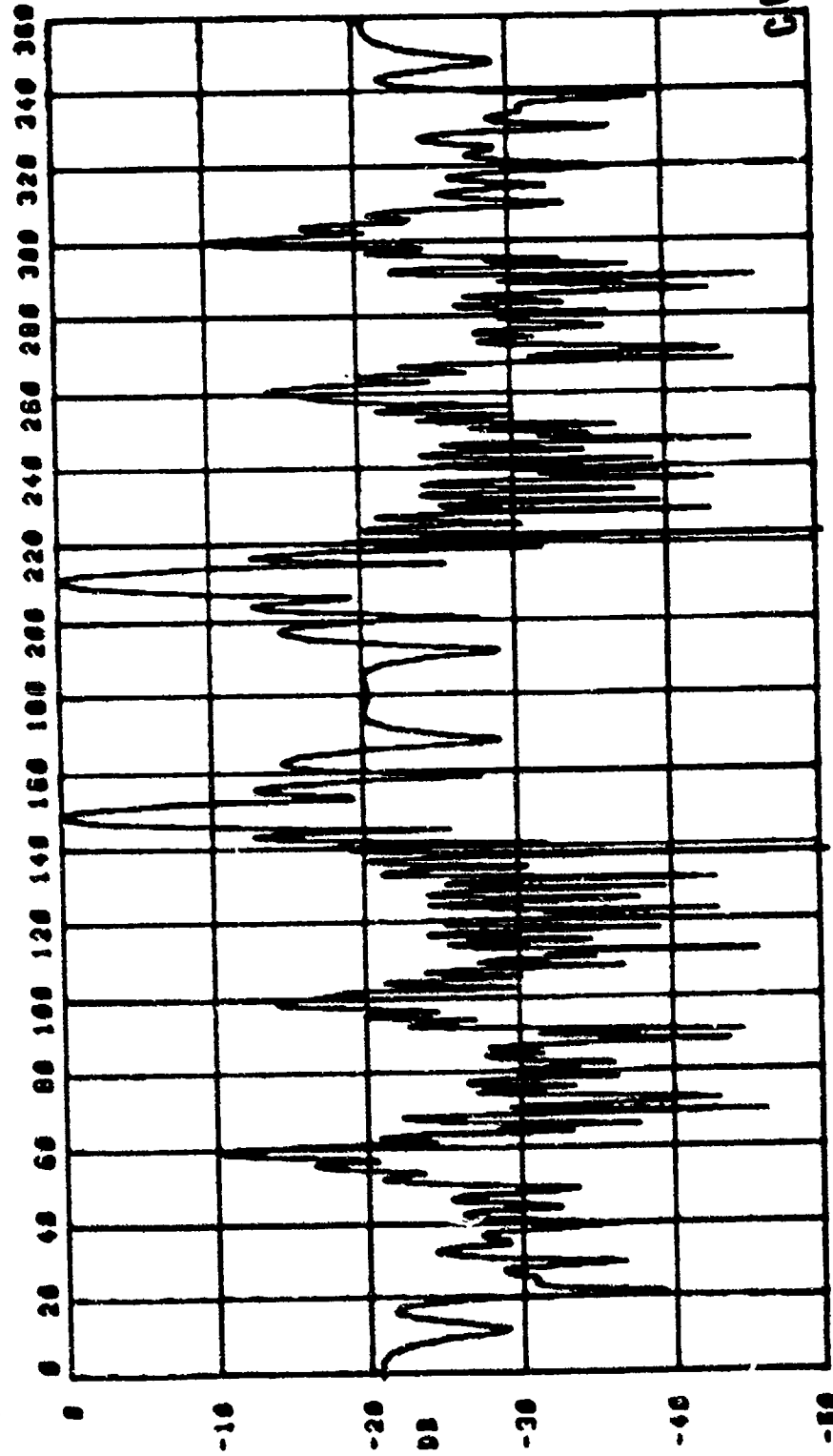


Figure B-27 Theoretical Horizontal Plane Pattern for 52 Element Array @ 290 Hz for Data Point 1, 59 Off Broadside Steering. Beamwidth 3.85°, Azimuth Gain 15.4 dB.

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51233 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 84-Jan-78 ONTSEP 3.1
 4: 34 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
 ELEMENTS 27 AND 28 DELETED FROM APERTURE.
 5: SAME

DATA POINTS 1 A 2
 1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
 290.0 HZ. 32 ELEMENTS. -9.04 DB MAX. AC:81542, SU:81642, MT:
 90.0 DEG. VERT. RESP. 149.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 5.03 DEG. 3 DB BEAM. 13.32 DB AZ. GAIN. MAX. AT 211.0 DEG. HORIZ.

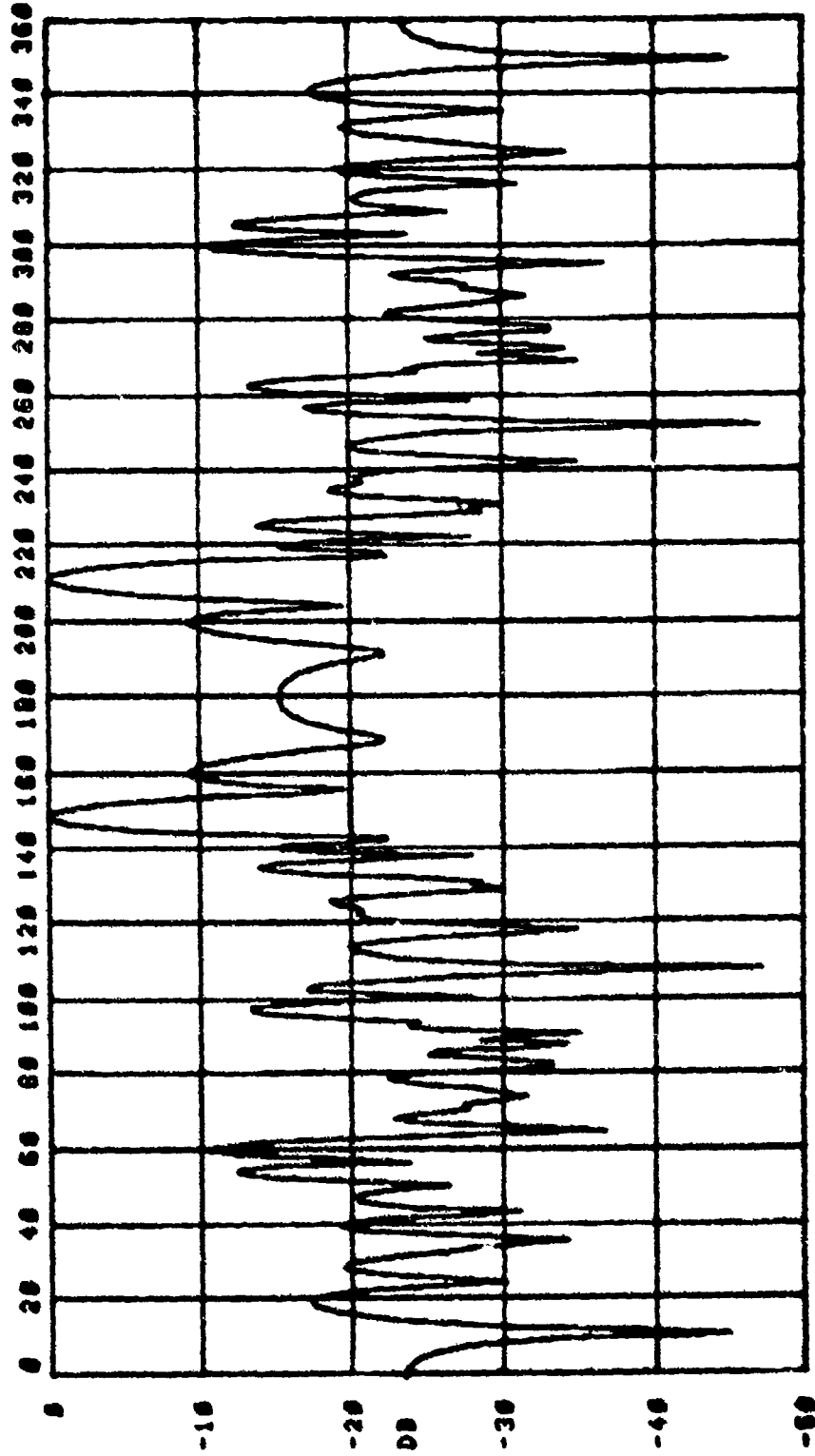


Figure B-28 Theoretical Horizontal Plane Pattern for 32 Element
 Array @ 290 Hz for Data Point 2, 59 Off Broadside
 Steering. Beamwidth 5.83°, Azimuth Gain 13.3dB.

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61231 SANDERS BEAM PATTERN PROGRAM (T.MOGAM) 24-Jan-70 ONYLP 3.1
 A: 16 ELEMENT SPRAY ARRAY. UNIFORMLY SPACED 0.23 FT.
 B: NO ARRAY DEFORMATION
 C: SAME

DATA POINT 1
 1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
 290.0 HZ. 16 ELEMENTS, -0.70 DB MAX. AC: S1541, SU: S1841, UT:
 90.0 DEG. VERT. RESP. 149.0 DEG. HORIZ. STEER. 90.0 DEG. VERT. STEER
 13.16 DEG. 3 DB BEAM. 10.46 DB AZ. GAIN. MAX. AT 150.0 DEG. HORIZ.

steer from
 B side

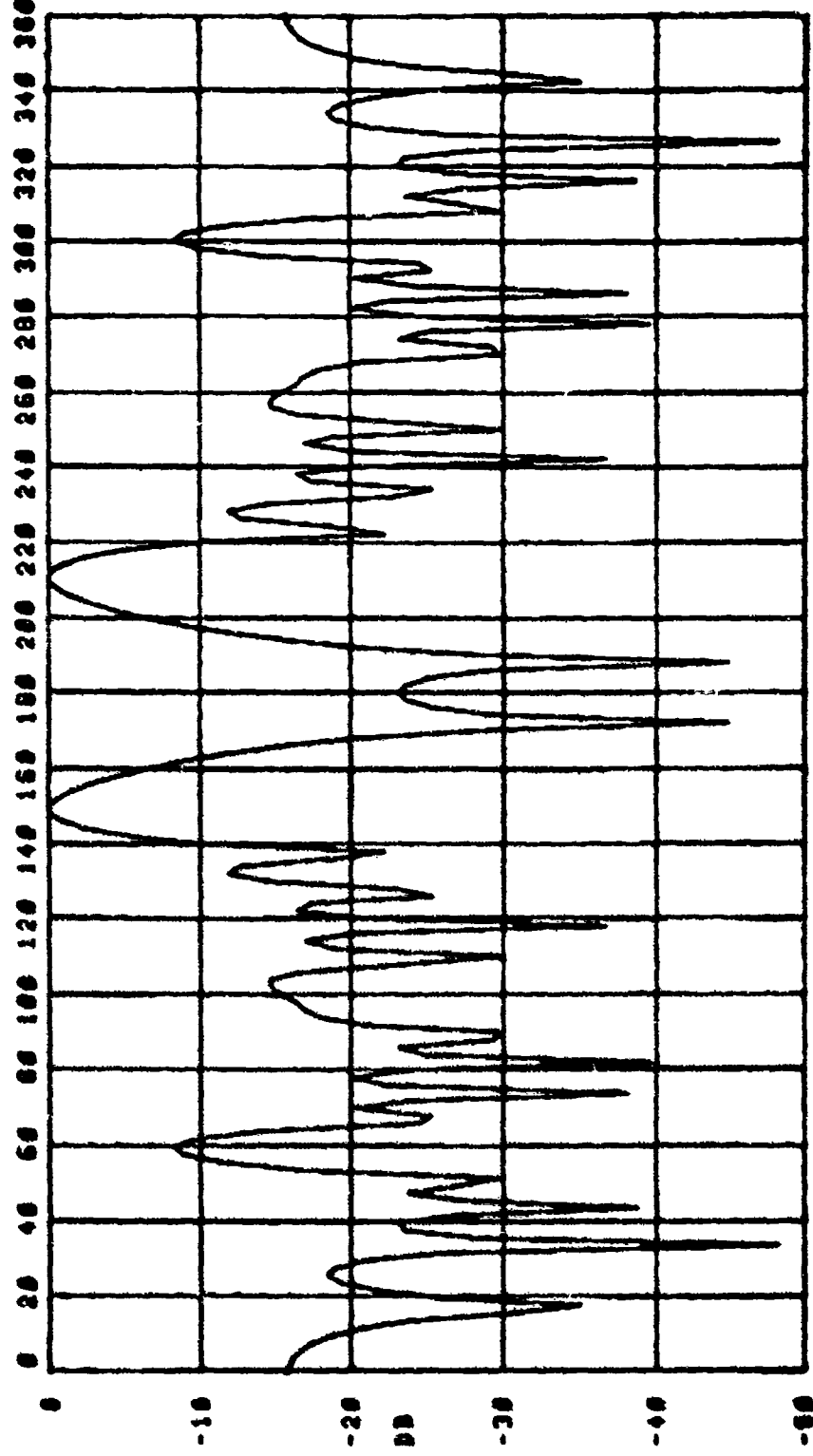


Figure B-29 Theoretical Horizontal Plane Pattern for 16 Element Array @ 290 Hz for Data Point 1, 59 Off Broadside Steering. Beamwidth 3.1°, Azimuth Gain 10.4 dB.

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81238 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 24-Jan-70 OUTLDP 3.1
 A: 53 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
 ELEMENT 18 DELETED FROM APERTURE
 S: SAME

DATA POINT 1
 1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
 295.0 HZ. 52 ELEMENTS. -0.04 DB MAX. AC:81543.SU:81543.MT:
 90.0 DEG. VERT. RESP. 149.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 3.77 DEG. 3 DB BEAM. 15.50 DB AZ. GAIN. MAX. AT 149.0 DEG. HORIZ.

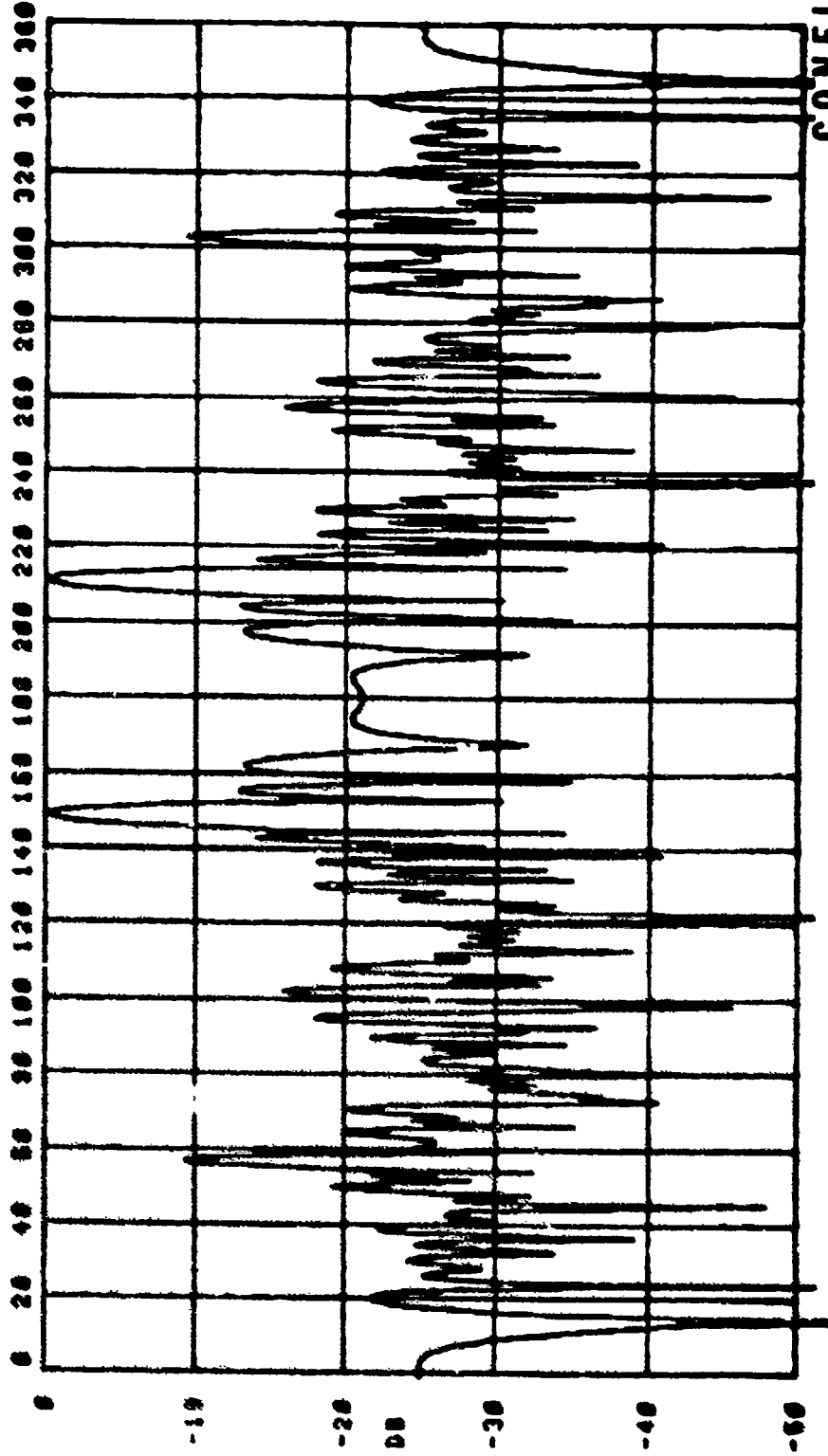


Figure 2-30 Theoretical Horizontal Plane Pattern for 52 Element Array @ 295 Hz for Data Point 1, 59 Off Broadside Steering. Beamwidth 3.77°, Azimuth Gain 15.5 dB.

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61236 SANDERS BEAM PATTERN PROGRAM (T. HOGAN) 24-Jan-70 ONTLEP 3.1
A: 53 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
ELEMENTS 15, 27 & 28 DELETED FROM APERTURE.
S: SAME

DATA POINTS 1 & 2
1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
295.0 HZ., 50 ELEMENTS, -0.83 DB MAX., AC:51544.SU:51544.MT:
90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.69 DEG. 3 DB BEAM, 15.38 DB AZ. GAIN, MAX. AT 211.0 DEG. HORIZ.

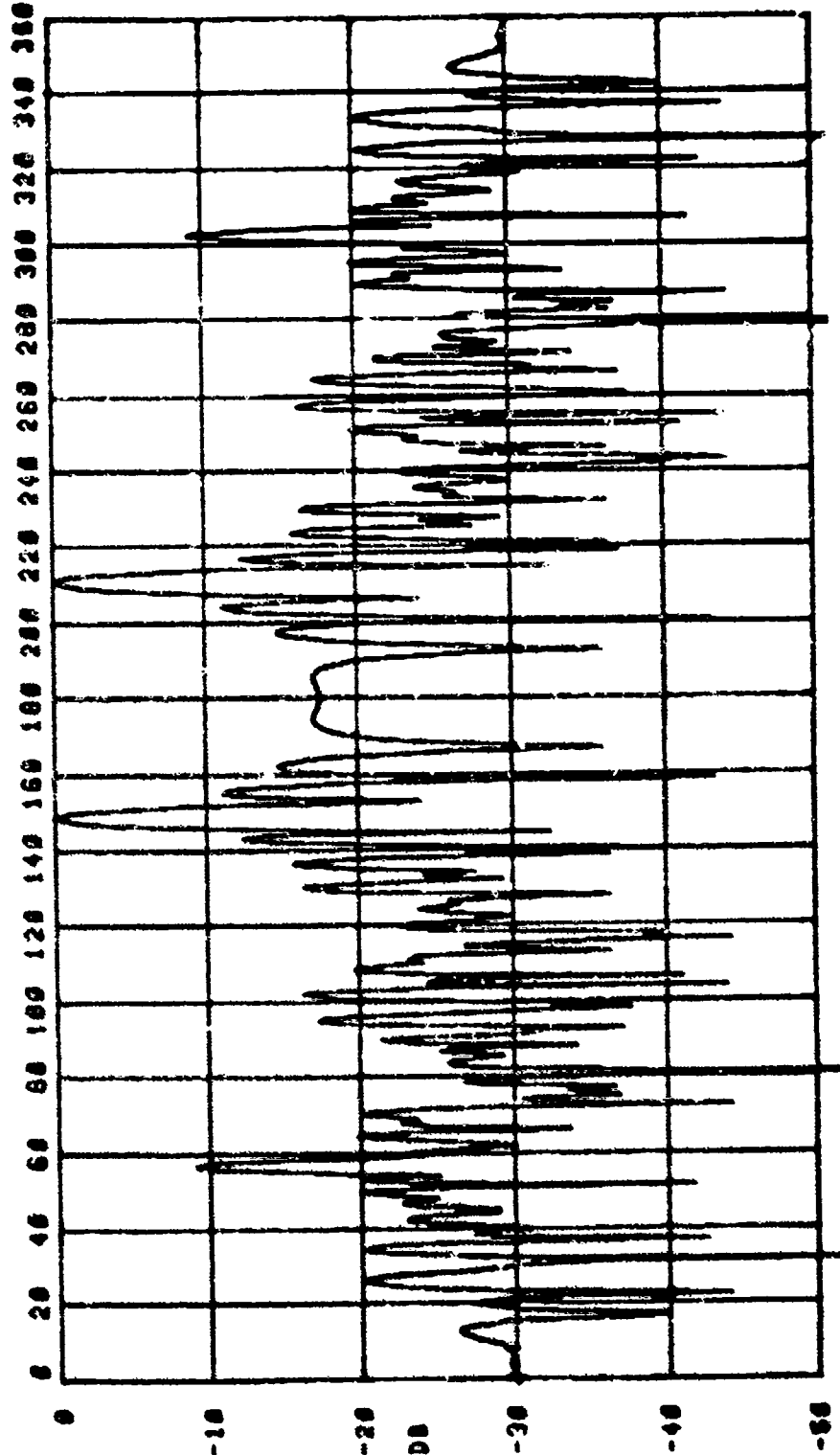


Figure B-3/ Theoretical Horizontal Plane Pattern for 50 Element Array @ 295 Hz for Data Point 2, 57 Off Broadside Steering. Beamwidth 3.49°, Azimuth Gain 15.3 dB.

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81234 SAMBERS BEAM PATTERN PROGRAM (T.MOGAN) 24-JAN-70 ONTLP 3.1
 A: 32 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
 ELEMENTS 27 AND 28 DELETED FROM APERTURE.
 S: SAME

DATA POINTS 1 & 2
 1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
 295.0 HZ. 32 ELEMENTS. -0.02 DB MAX.. AC:51542.SU:51542.MT:
 90.0 DEG. VERT. RESP.. 149.0 DEG. HORIZ. STEER. 50.0 DEG. VERT STEER
 5.79 DEG. 3 DB BEAM. 13.44 DB AZ. GAIN. MAX. AT 149.0 DEG. HORIZ.

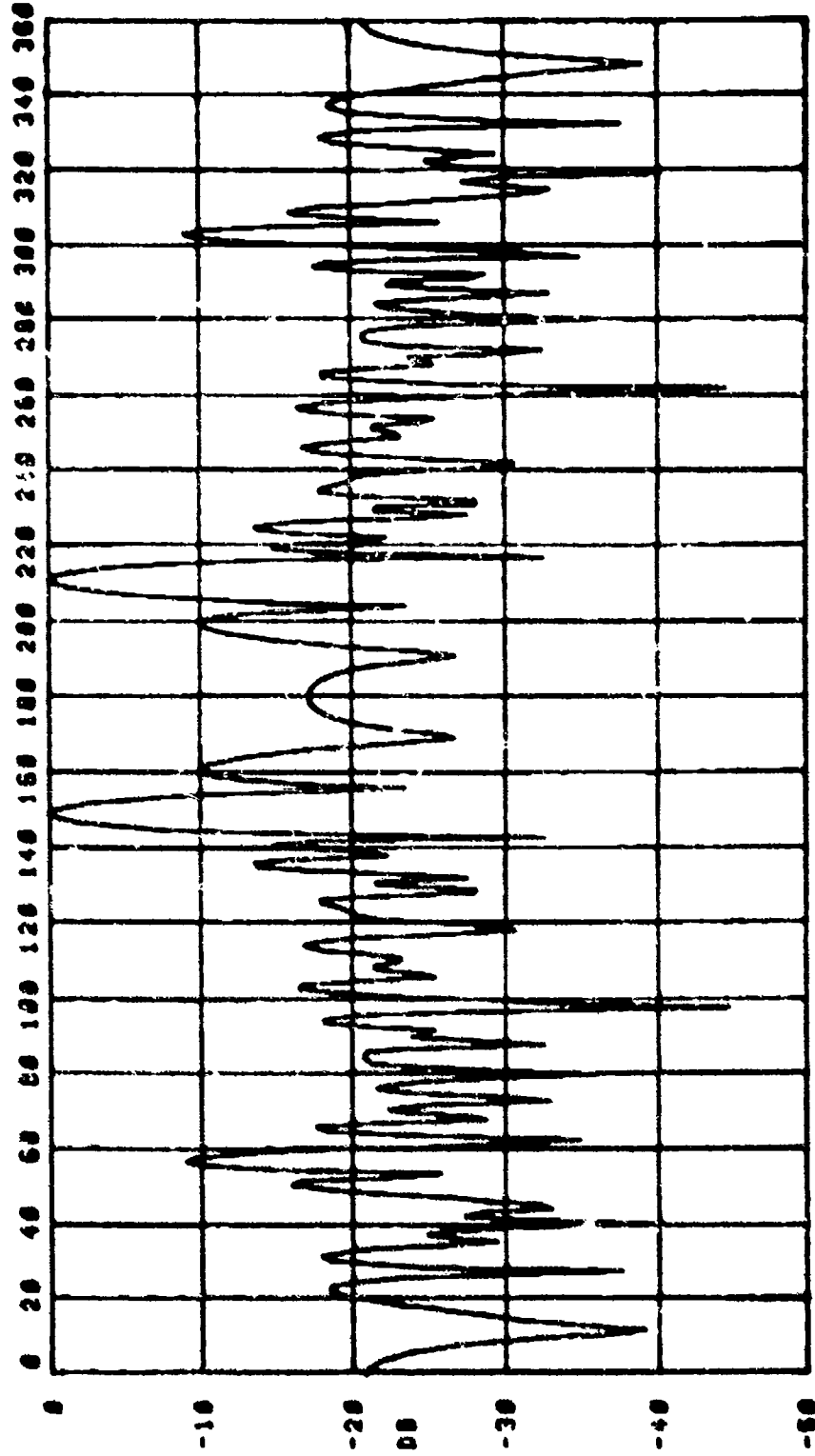


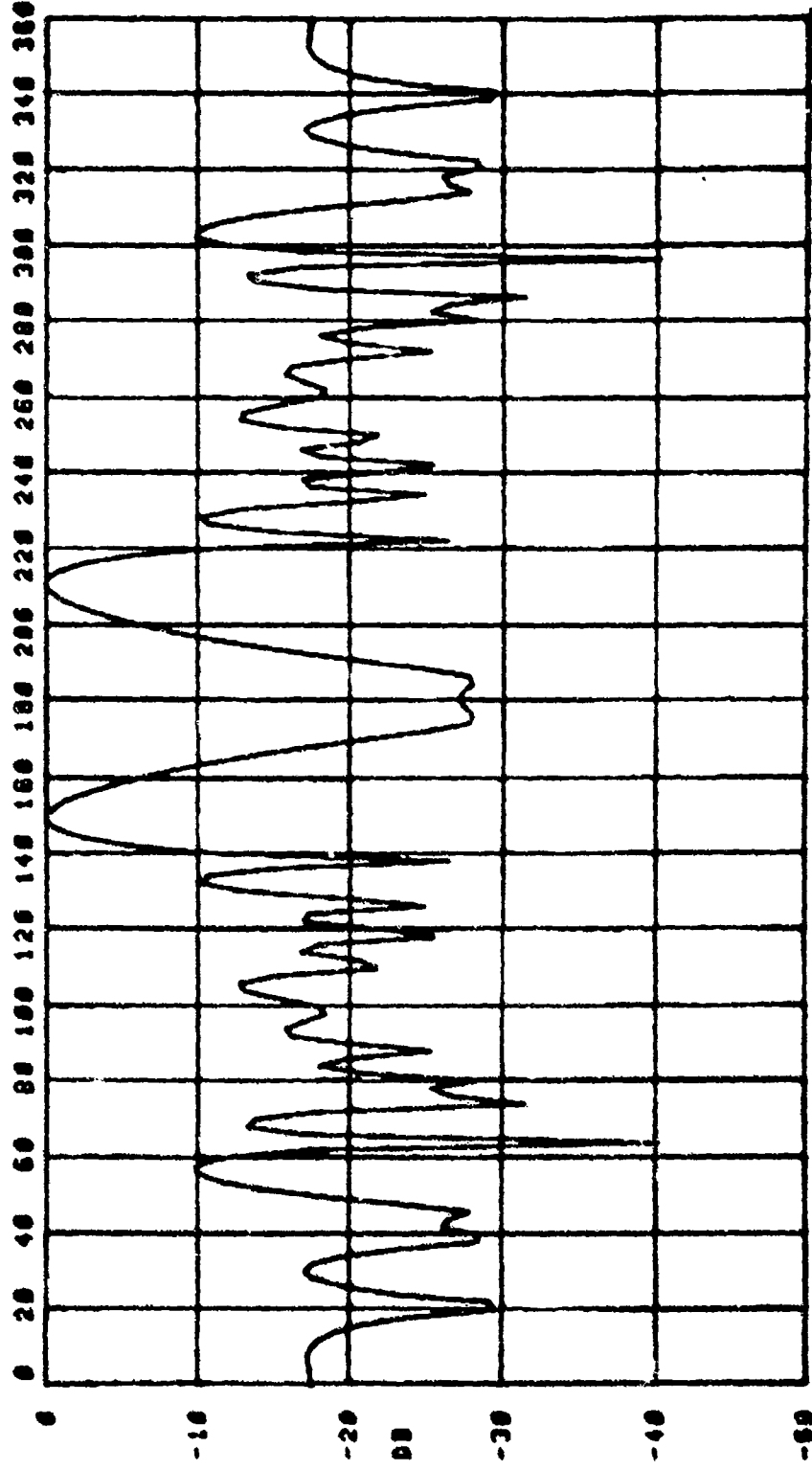
FIGURE E-32 THEORETICAL HORIZONTAL PLANE PATTERN FOR 32 ELEMENT
 ARRAY 1200 HZ FOR DATA POINT 42, 59 SEE BROGSIDE
 STEERING. BEAMWIDTH 5.79°, AZIMUTH GAIN 13.44 DB.

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51232 SAMBERS BEAM PATTERN PROGRAM (T.MOGAN) 24-JAN-70 0945DF 3.1
 A: 16 ELEMENT SPRAY ARRAY. UNIFORMLY SPACED 8.33 FT.
 NO ARRAY DEFORMATION
 S: SAME

DATA POINT 1
 1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
 295.0 HZ., 16 ELEMENTS, -0.90 DB MAX., AC:51541, SU:51541, MT:
 90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 13.07 DEG. 3 DB BEAM, 10.33 DB AZ. GAIN, MAX. AT 152.0 DEG. HORIZ.



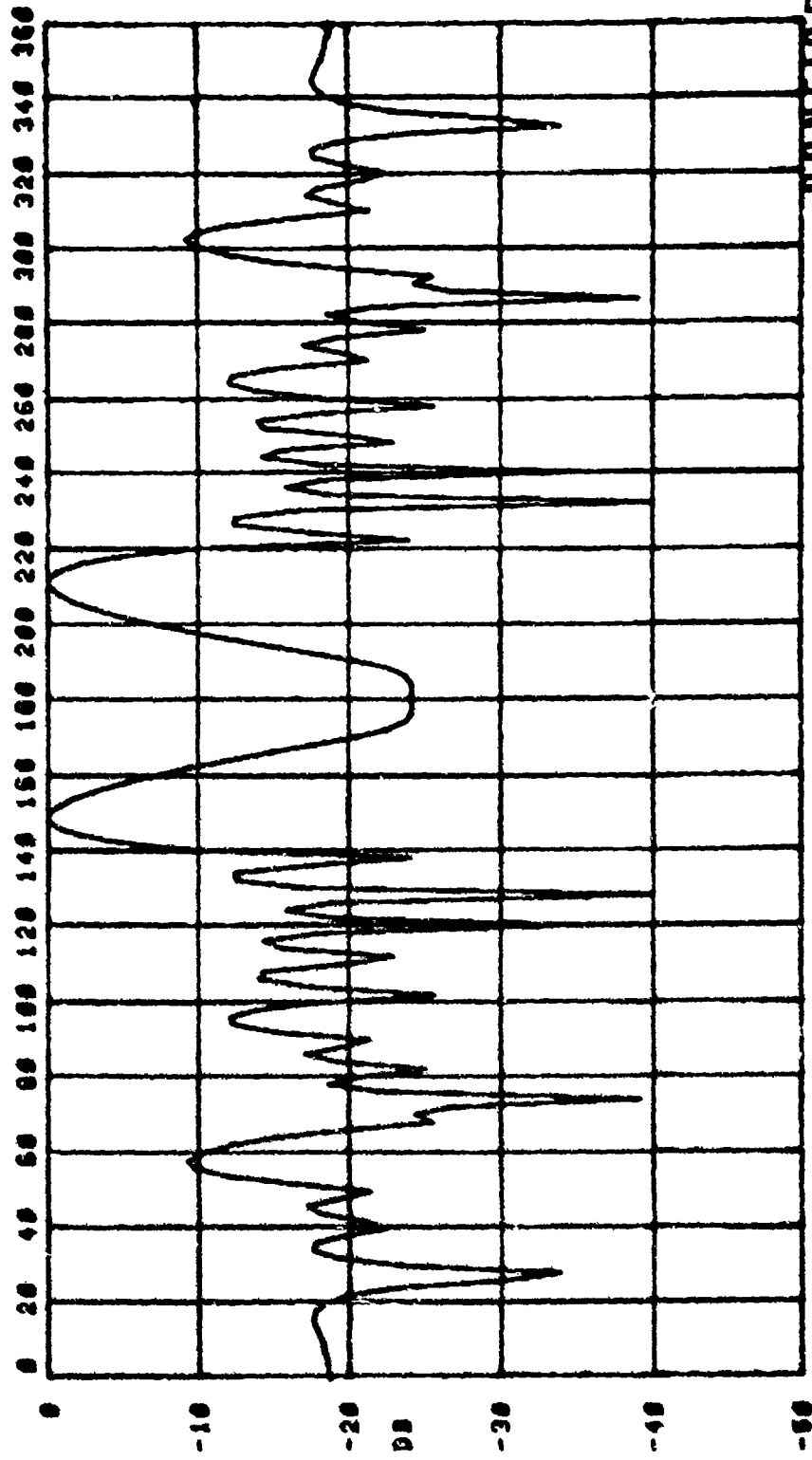
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Figure 3-33 Theoretical Horizontal Plane Pattern for 16 Element
 Array at 295 Hz for Data Point 1, 59 Off Broadside
 Steering. Beamwidth 13.07°, Azimuth Gain 10.3 dB.

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81239 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 24-JAN-70 ONTLP 3.1
 A: 53 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
 ELEMENT 15 DELETED FROM APERTURE
 B: SAME

DATA POINT 2
 1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
 290.0 HZ. 15 ELEMENTS, -0.07 DB MAX.. AC:51543.SU:51543.UT:
 90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 12.70 DEG. 3 DB BEAM, 10.37 DB AZ. GAIN, MAX. AT 212.0 DEG. HORIZ.



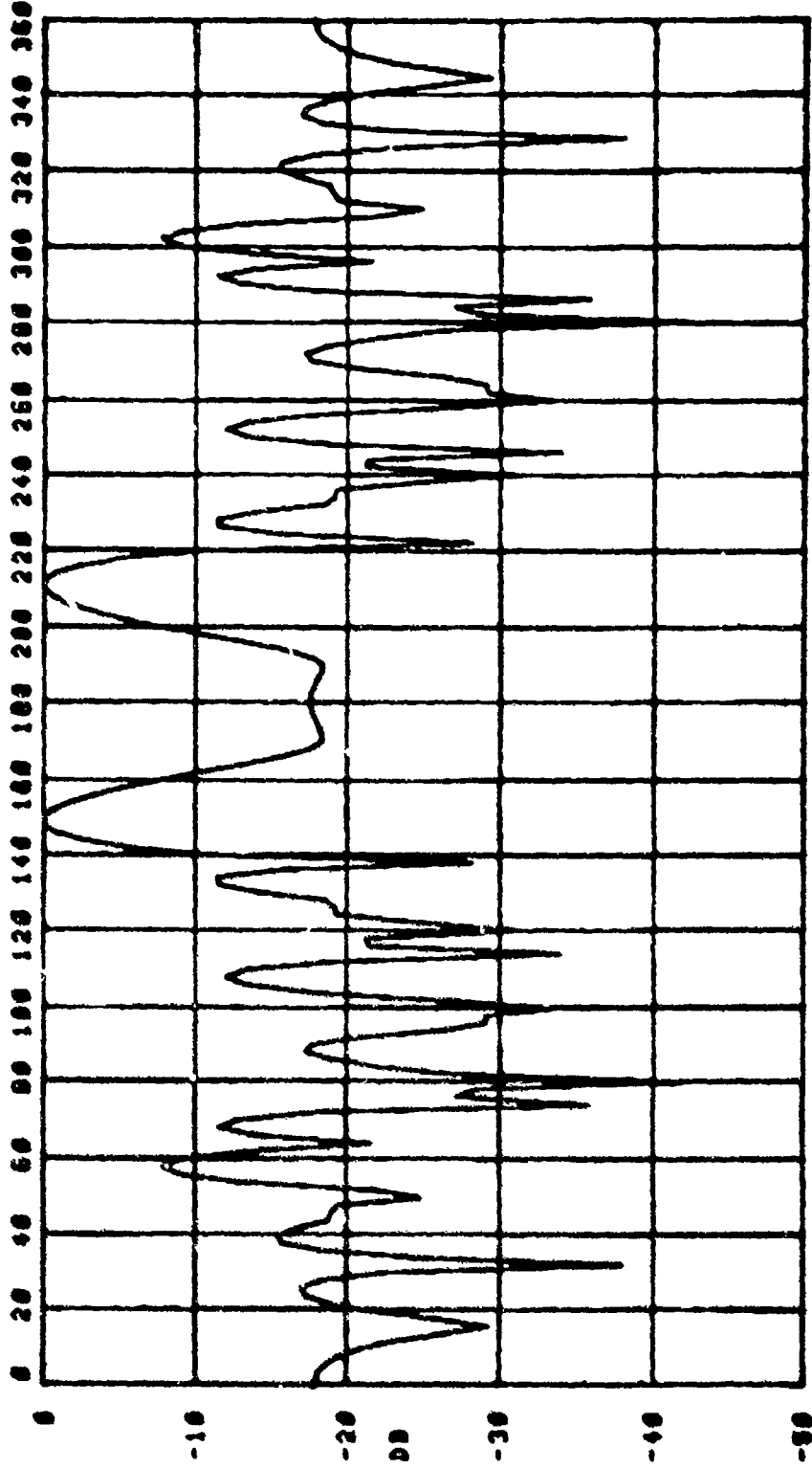
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Figure B-34 Theoretical Horizontal Plane Pattern for 16 Element Array at 290 Hz for Data Point 2, 59 Off Broadside Steering. Beamwidth 12.7°, Azimuth Gain 10.3 dB.

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8123A SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 24-JUN-70 ONTLP 3.1
 A: 53 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
 ELEMENT IS DELETED FROM APERTURE
 S: SAME

DATA POINT 2
 1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
 255.0 HZ. 16 ELEMENTS. -0.06 DB MAX., AC:51543, SU:51543, UT:
 90.9 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 12.31 DEG. 3 DB BEAM, 10.44 DB AZ. GAIN, MAX. AT 212.0 DEG. HORIZ.



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Figure 2-35 Theoretical Horizontal Plane Pattern for 16 Element
 Array @ 295 Hz for Data Point 2, 59 Off Broadside
 Steering. Beamwidth 12.31°, Azimuth Gain 10.4 dB.

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SC278 SAM288 BEAM PATTERN PROGRAM (T.MOGAN) 20-FEB-78 ONTLP 3.1
 4: SPAN(AREA) TUNED TO 300 HZ.
 6.1233 FT. UNIFORM SPACING.
 8: SAME

DATA POINT 3
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 292.0 HZ.. 81 ELEMENTS. -0.82 DB MAX.. AC:52581.6U:52581.4T:
 90.0 DEG. VERT. RESP.. 115.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 2.16 DEG. 3 DB BEAM. 17.24 DB AZ. GAIN. MAX. AT :16.0 DEG. HORIZ.

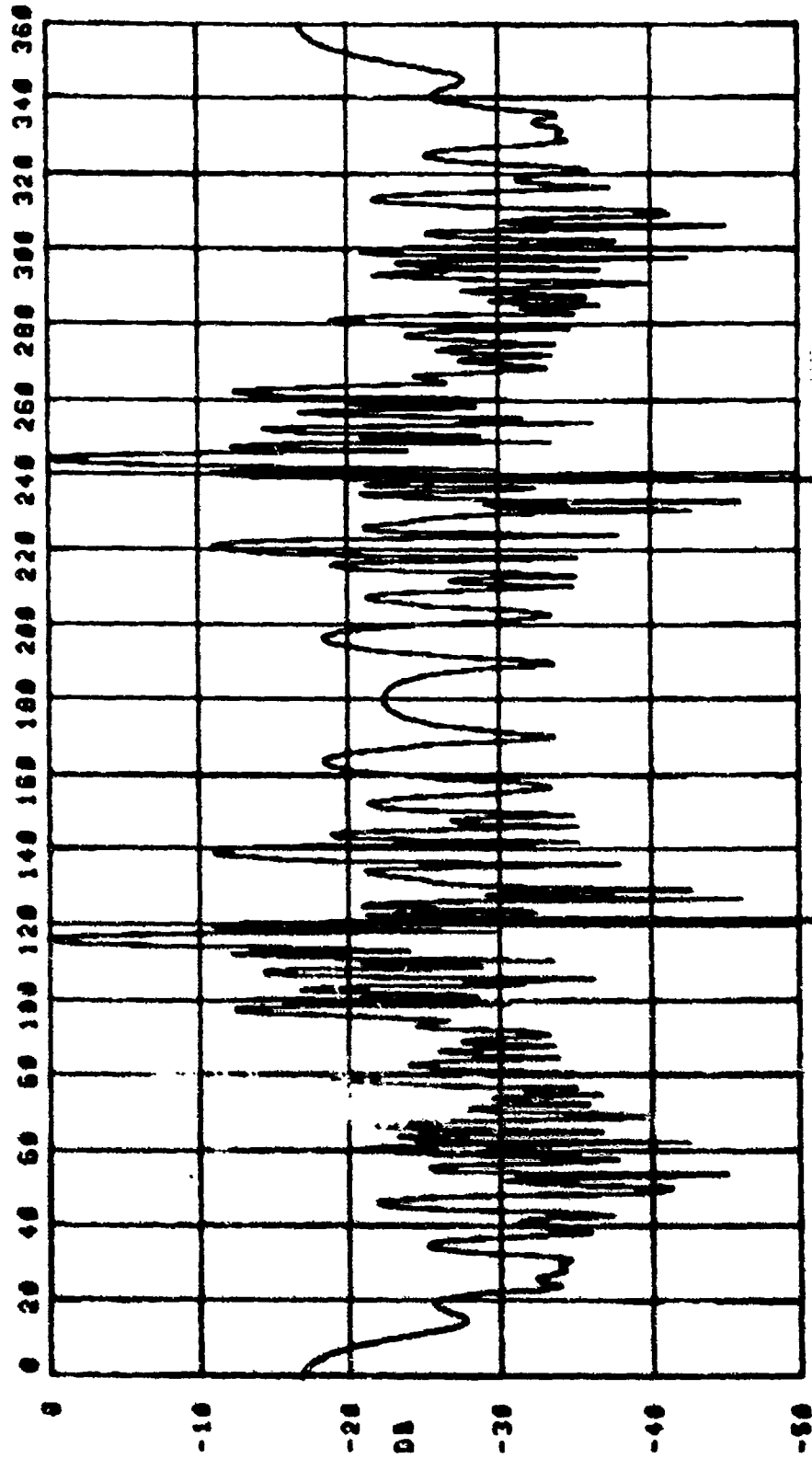


Figure B-36 Theoretical Horizontal Plane Pattern for 51 Element
 Array @ 290 Hz for Data Point 3, 26 Off Broadside
 Steering. Beamwidth 2.16°, Azimuth Gain 17.2 dB.

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522'S SANDERS BEAM PATTERN PROGRAM (T. HOGAN) 20-FEB-78 ONTLP 3.1
 A: 2'RAY AREA) TUNE2 TO 300 MZ.
 S: 3223 FT. UNIFORM SPACING.
 S: SMT

DATA POINT 3
 1200 MZ SAMPLING FREQUENCY DISTORTS PATTERN.
 120.0 MZ. 32 ELEMENTS. -8.02 DB MAX., AC:52501, SU:52501, MT:
 90.0 DEG. VERT. RESP. 118.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 3.45 DEG. 3 DB BEAM. 15.20 DB A2. GAIN. MAX. AT 116.0 DEG. HORIZ.

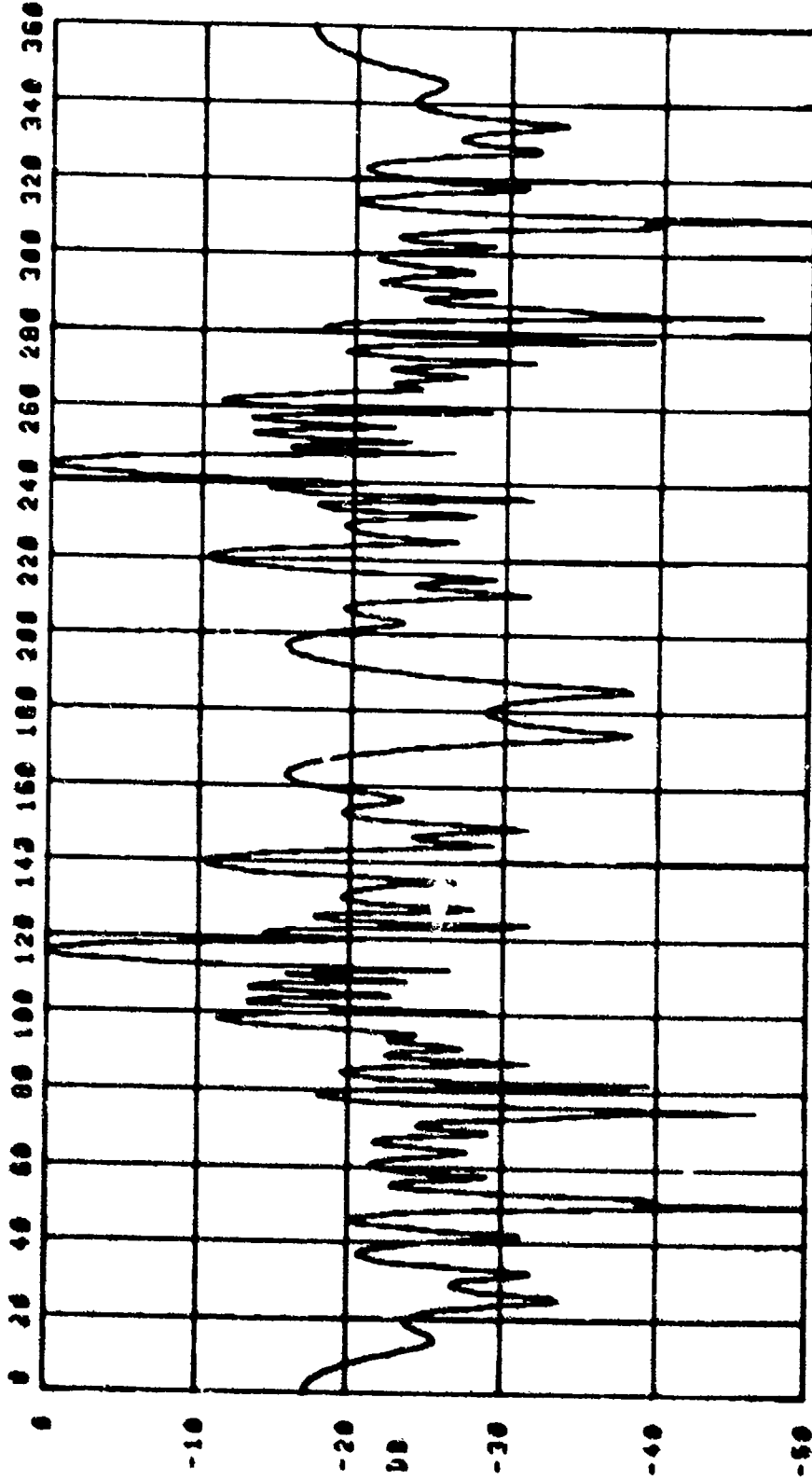


Figure E-27 Theoretical Horizontal Plane Pattern for 32 Element Array 1.290 Hz for Data Point 3, 26 Off Broadside Steering. Beamwidth 3.45°, Azimuth Gain 15.2 dB.

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S4278 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 20-FEB-70 ONTLP 3.1
 A: SPEAK (ARRA) TUNED TO 300 HZ.
 S: 3233 FT. UNIFORM SPACING.
 S: SAME

DATA POINT 3
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 290.0 HZ. 16 ELEMENTS, -0.75 10 MAX., AC:52581.6U:52581.UT:
 90.0 DEG. VERT. RESP., 116.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 7.27 DEG. 3 DB BEAM, 12.25 DB AZ. GAIN, MAX. AT 116.0 DEG. HORIZ.

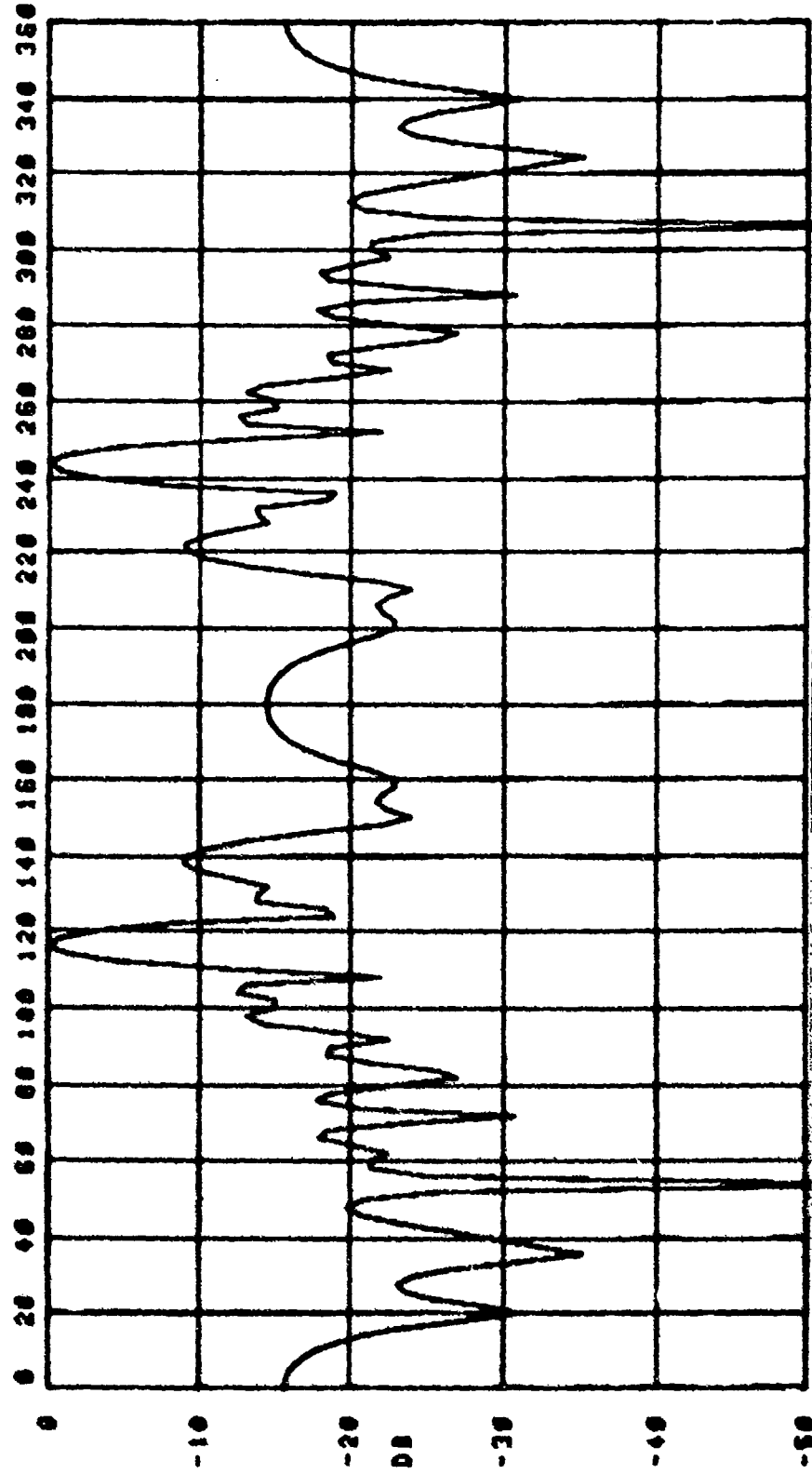


Figure B-38 Theoretical Horizontal Plane Pattern for 16 Element
 Array @ 290 Hz for Data Point 3, 26 Off Broadside
 Steering. Beamwidth 7.27°, Azimuth Gain 12.2 dB.

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5:277 SAMBERS BEAM PATTERN PROGRAM (T.MOGAN) 20-FEB-70 ONTLP 3.1
A: 5FRE1 AREA1 TUNED TO 300 MZ.
6.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 3
1200 MZ SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 MZ., 51 ELEMENTS, -0.19 DB MAX., AC:52501, SU:52501, UT:
90.0 DEG. VERT. RESP., 115.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.47 DEG. 3 DB BEAM. 15.12 DB AZ. GAIN, MAX. AT 115.0 DEG. HORIZ.

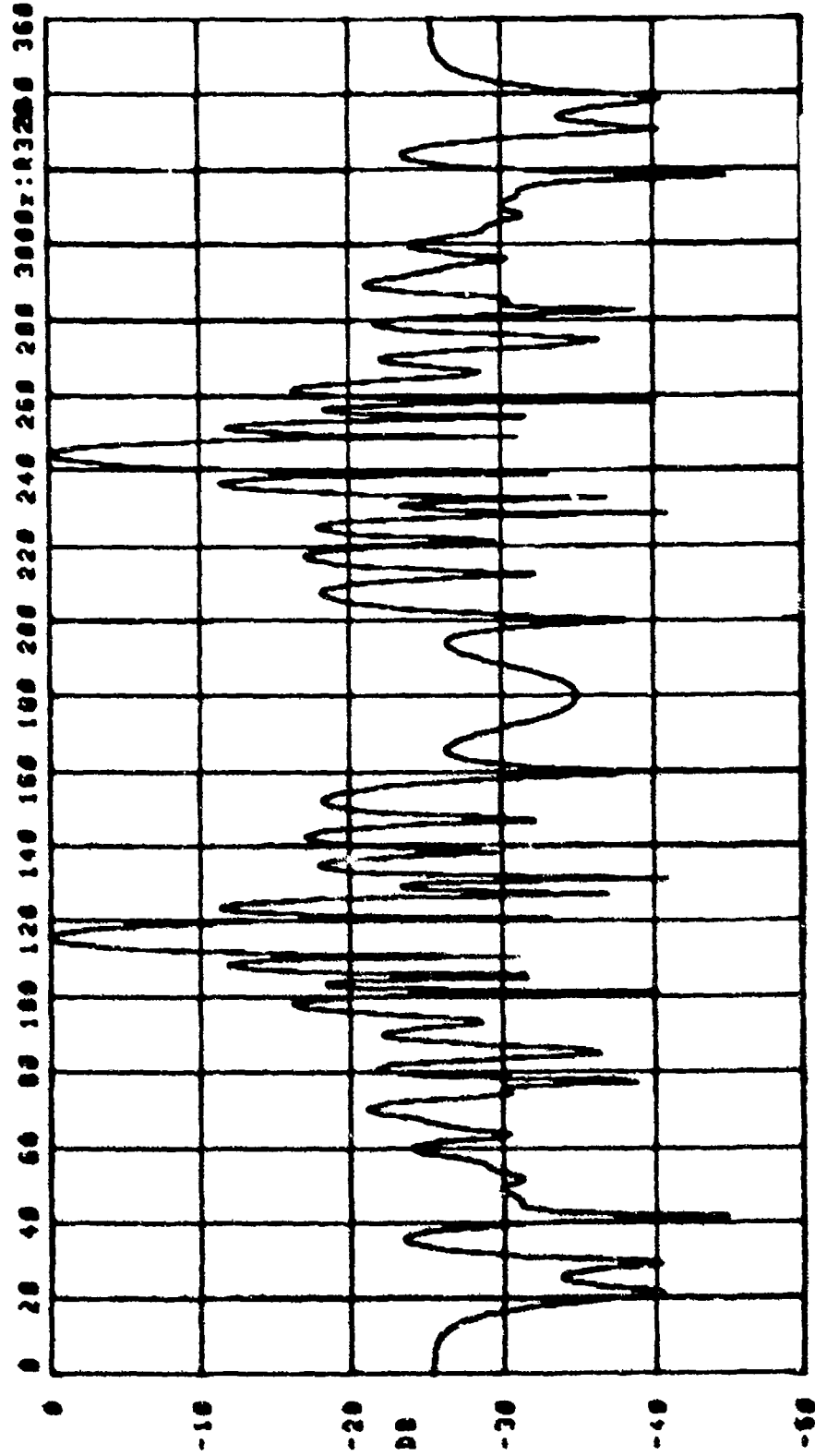


Figure 2-39 Theoretical Horizontal Plane Pattern for 5/Element
Array @ 140 MZ for Data Point 3, 26 Off Broadside
Steering. Beamwidth 4.47°, Azimuth Gain 15.1 dB.

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51274 SANDERS BEAM PATTERN PROGRAM (T.MOEN) 20-FEB-78 ONTAP 3 1
 A: SPENT AREA) TUNED TO 300 HZ.
 B: 3.333 FT. UNIFORM SPACING.
 C: SAME

DATA POINT 3
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 100.0 HZ. 32 ELEMENTS. -0.10 DB MAX.. AC:52881.SU:52881.MT:
 90.0 DEG. VERT. RESP.. 116.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 7.16 DEG. 3 DB BEAF. 13.13 DB AZ. GAIN. MAX. AT 115.8 DEG. HORIZ.

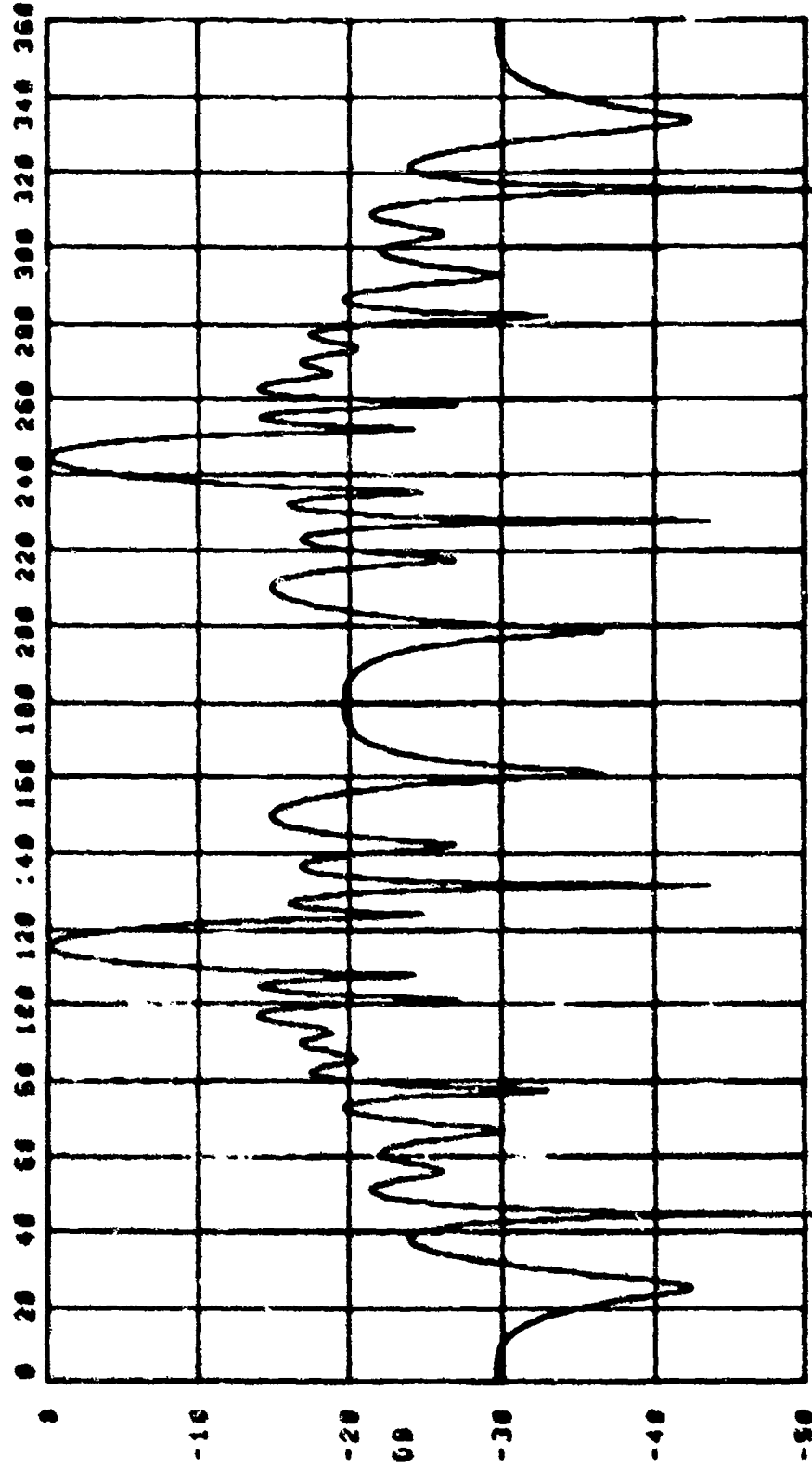


Figure B-40 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 HZ for Data Point 3. 26 Off Broadside Steering. Beamwidth 7.16°, Azimuth Gain 13.1 dB.

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52471 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 20-Feb-70 ONTLP 3.1
 A: 52471 AERAT TUNED TO 300 HZ.
 6.2332 FT. UNIFORM SPACING.
 S: SAME

DATA POINT 2
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 140.0 HZ., 16 ELEMENTS, -0.16 DB MAX., AC:52501-SU:52601.MT:
 50.0 DEG. VERT. RESP., 116.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 15.10 DEG. 3 DB BEAM. 10.01 DB AZ. GAIN, MAX. AT 116.0 DEG. HORIZ.

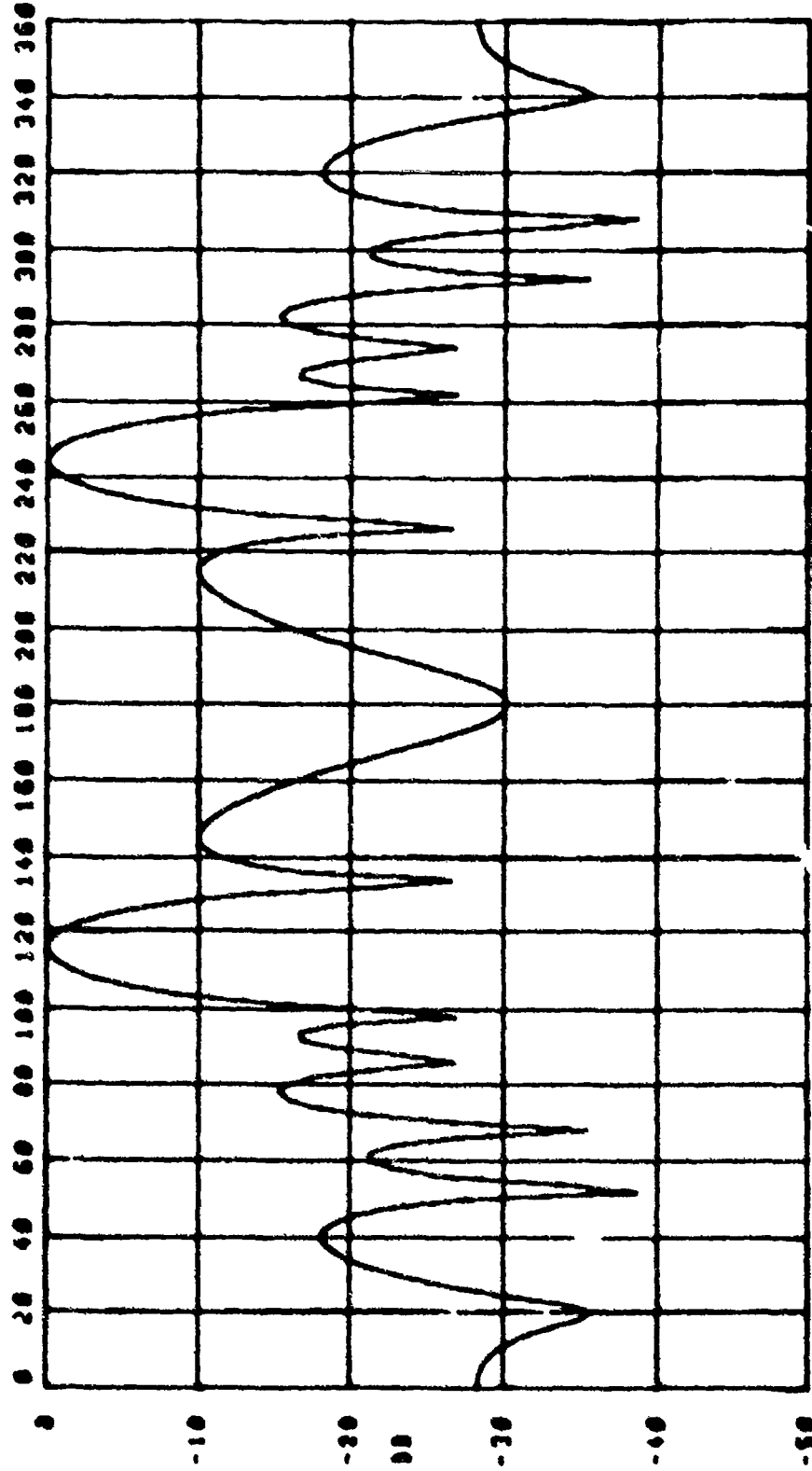


Fig. 20 B-41 Theoretical Horizontal Plane Pattern for 16 Elements
 Array & 1160 HZ for Data Point 3, 26 Off Broadside
 Steering. Beamwidth 15.1°, Azimuth Gain 10.0 dB.

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S2279 SANDERS BEAM PATTERN PROGRAM (T.MOGAM) 20-FEB-70 ONTLP 3.1
 A: SFRAT AREA1 TUNED TO 300 HZ.
 S: 3333 FT. UNIFORM SPACING.
 S: SAME

DATA POINT 3
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 205.0 HZ. 51 ELEMENTS. -0.01 DB MAX. AC:52501-SU:52501.MT:
 50.0 DEG. VERT. KEEP. 116.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 2.12 DEG. 3 DB BEAM. 17.35 DB AZ. GAIN. MAX. AT 116.0 DEG. HORIZ.

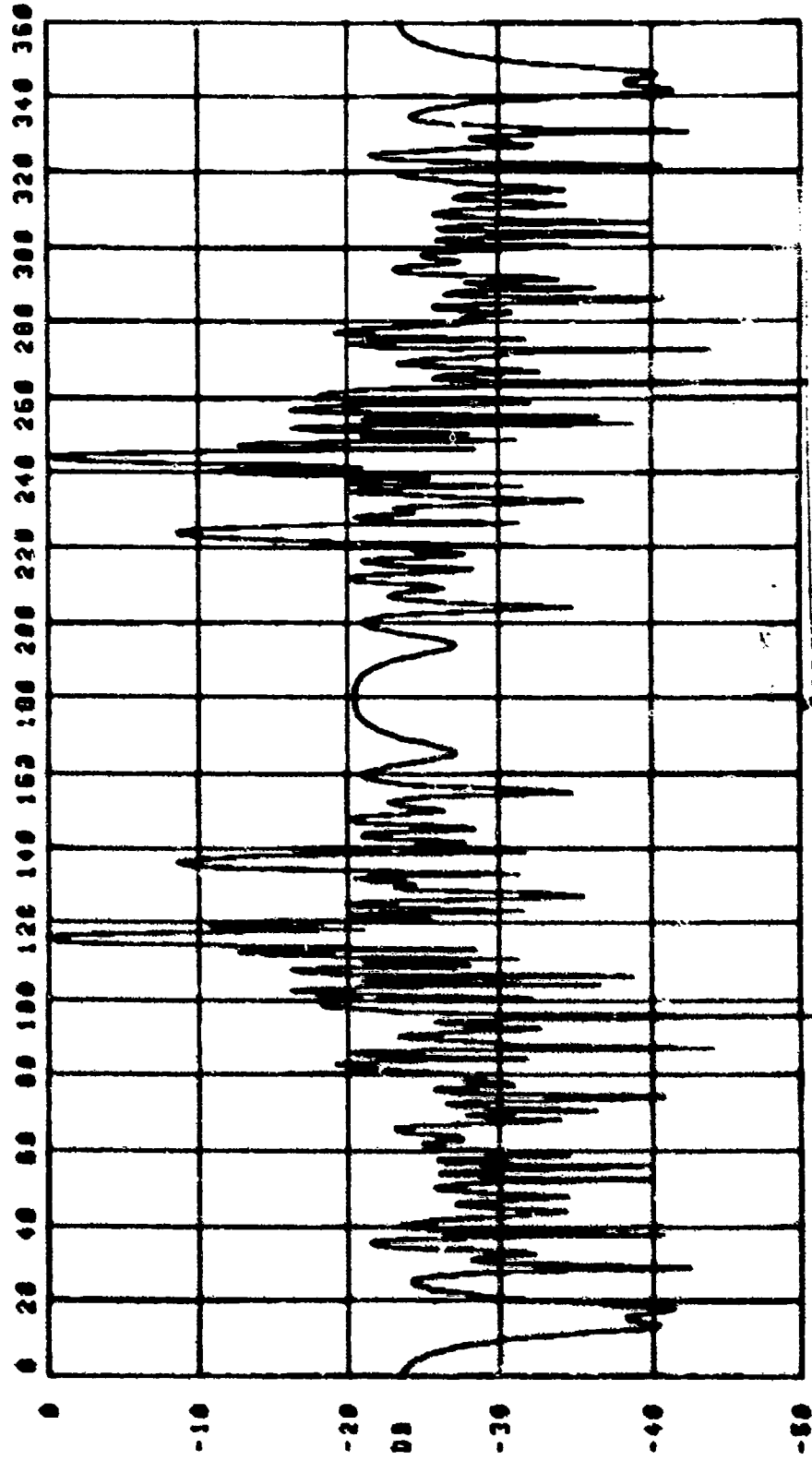


Figure B-42 Theoretical Horizontal Plane Pattern for 51 Element Array @ 295 Hz for Data Point 3, 26 Steering. Beamwidth 2.12°, Azimuth Gain 17.3 dB.

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S2476 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 20-Feb-70 ONTLEP 3.1
A: SFE61 ARRAY TUNED TO 300 HZ.
S: 5.3323 FT. UNIFORM SPACINGS.
S: SAME

DATA POINT 3
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ. 32 ELEMENTS. -0.82 DB MAX.. AC:S2581.SU:S2581.WT:
90.0 DEG. VERT. RESP.. 116.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
3.42 DEG. 3 DB BEAM. 15.29 DB AZ. GAIN. MAX. AT 116.0 DEG. HORIZ.

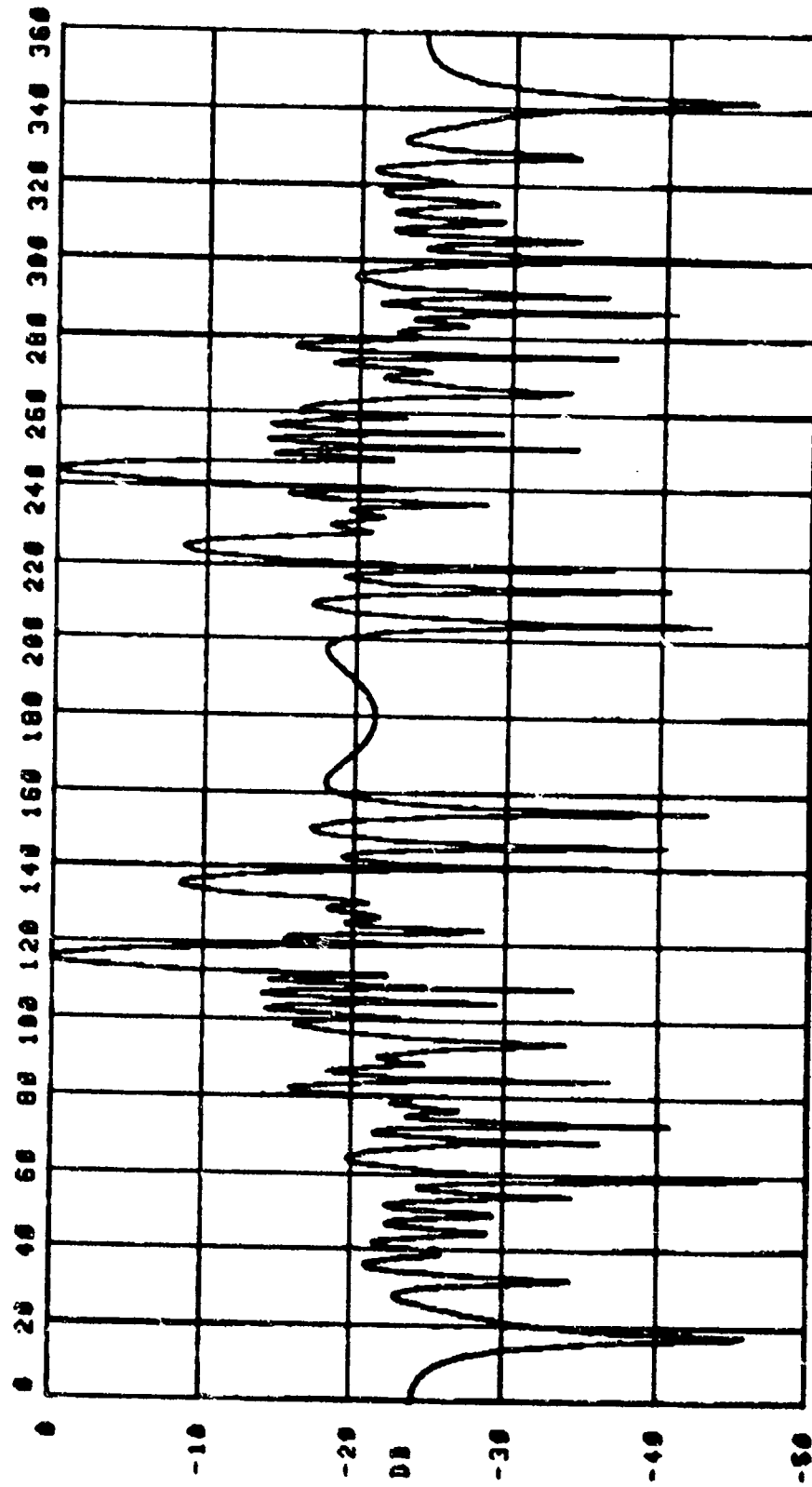


Figure B-43 Theoretical Horizontal Plane Pattern for 32 Element Array at 295 Hz for Data Point 3, 26 Off Broadside Steering. Beamwidth 3.42°, Azimuth Gain 15.29 dB.

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S2271 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 20-FEB-70 ONTLEP 3.1
 A: SPRAY AREA1 TUNED TO 300 MHZ.
 E-3323 FT. UNIFORM SPACING.
 S: SAME

DATA POINT 3
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 295.0 HZ., 16 ELEMENTS, -0.77 DB MAX., AC:S2581, SU:S2581, WT:
 50.0 DEG. VERT. RESP., 116.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 7.05 DEG. 3 DB BEAM, 12.39 DB AZ. GAIN, MAX AT 116.0 DEG. HORIZ.

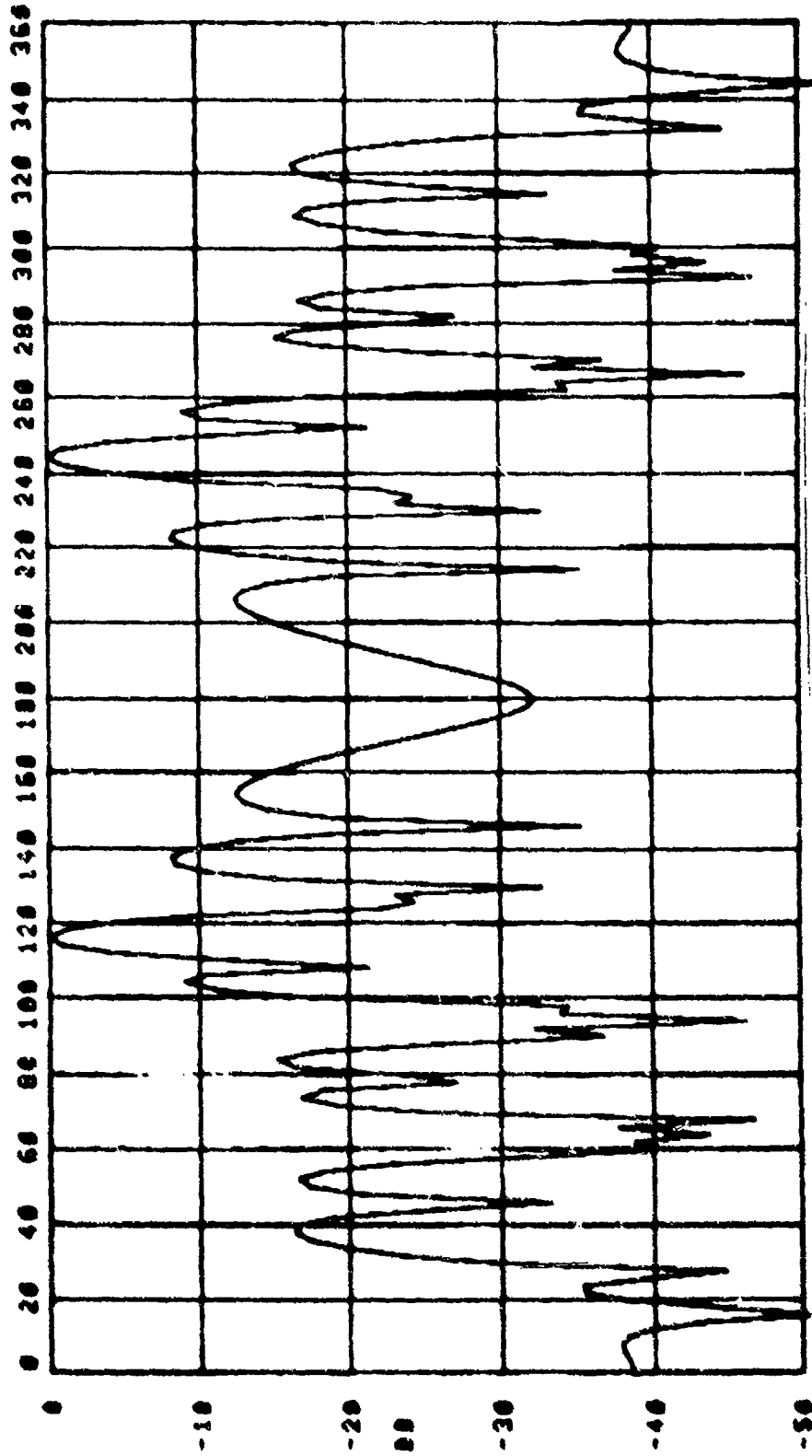


FIGURE 2-44 THEORETICAL HORIZONTAL PLANE PATTERN FOR 16 ELEMENT
 ARRAY AT 295 HZ FOR DATA POINT 3, 26.0 DB BROADSIDE
 STEERING, Beamwidth 7.05°, Azimuth Gain 12.39 DB.

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5227M SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 26-FEB-70 0N1LBP 3.1
 A: SFEAT AREA) TUNED TO 300 HZ.
 B: 3333 FT. UNIFORM SPACING.

S: SAME

DATA POINT 4

1200 HZ SAMPLING FREQUENCY) DISTORTS PATTERN.
 250.0 HZ. 51 ELEMENTS. 0.79 DB MAX.. AC:52581.SU:52581.WT:
 50.0 DEG. VERT. RESP. 124.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 2.33 DEG. 3 DB BEAM. 17.15 DB AZ. GAIN. MAX. AT 236.0 DEG. HORIZ.

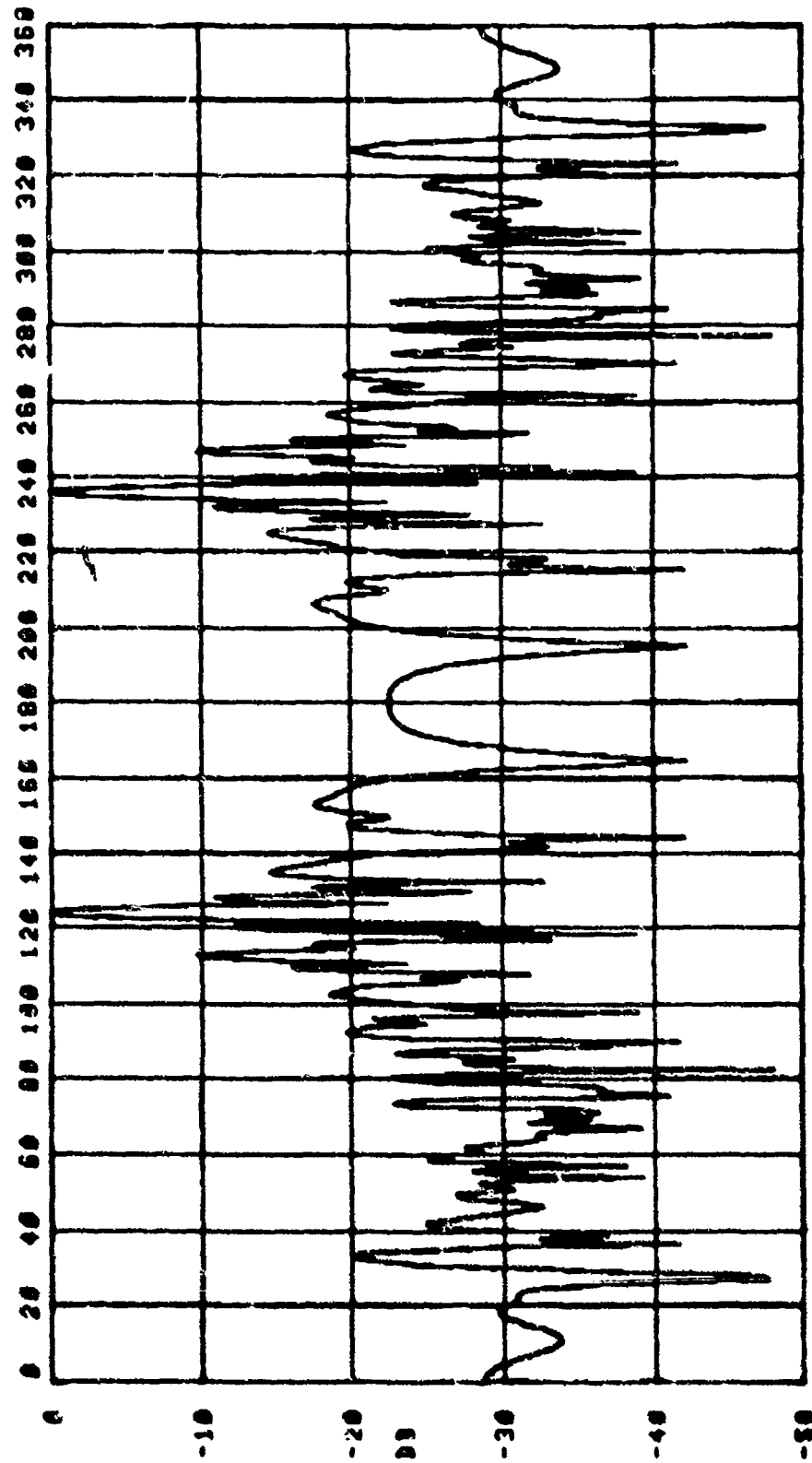


Figure B-45 Theoretical Horizontal Plane Pattern for 51 Element
 Array @ 290 Hz for Data Point 4, 34 Off Broadside
 Steering. Beamwidth 2.33°, Azimuth Gain 77.1 dB.

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SIZE SAMBERS BEAM PATTERN PROGRAM (Y.HOGAN) 20-FEB-70 ONTLP 3.1
 A: SFE41 ARRM) TUNED TO 300 MZ.
 6.3333 FT. UNIFORM SPACING.
 S: SAME

DATA POINT 4
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 290.0 MZ., 32 ELEMENTS, -0.90 DB MAX., AC:52581.5U:52581.1MT:
 50.0 DEG. VERT. WESP., 124.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 3.00 DEG. 3 DB BEAM. 14.56 DB AZ. GAIN. MAX. AT 124.5 DEG. HORIZ.

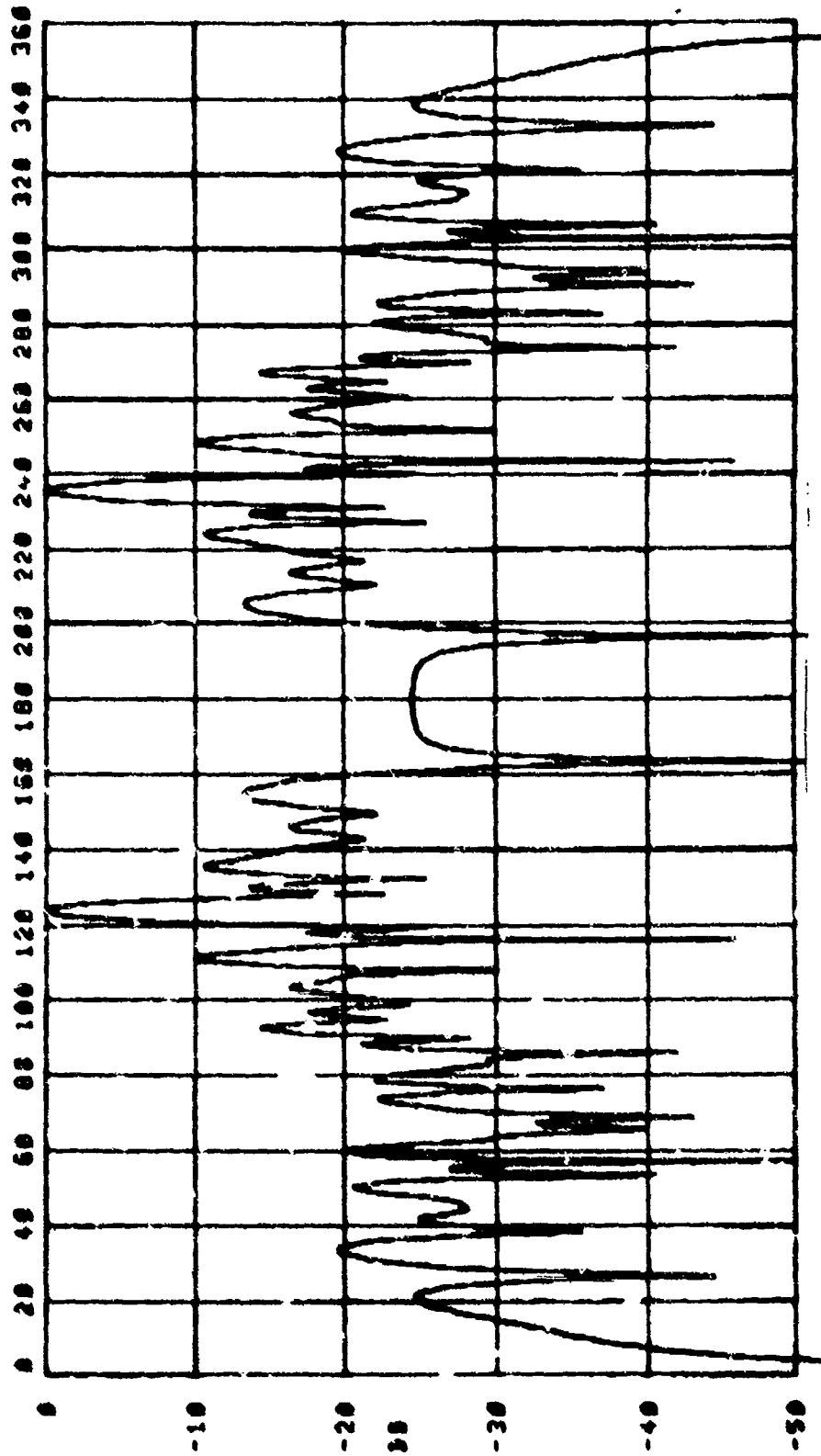


FIGURE 2-46 THEORETICAL HORIZONTAL PLANE PATTERN FOR 32 ELEMENT
 ARRAY @ 290 MZ FOR DATA POINT 4, 34 SEE Broadside
 Steering. Beamwidth 3.80, Azimuth Gain 14.9 dB.

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S:2278 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 28-Feb-78 ONTLP 3.1
A: SFRM1 ARR1 TUNED TO 300 MZ.
S: 3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 4
1200 MZ SAMPLING FREQUENCY DISTORTS PATTERN.
196.0 MZ. 16 ELEMENTS, -0.55 DB MAX., AC:S2581, SU:S2581, MT:
90.0 DEG. VERT. RESP. 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.90 DEG. 3 DB BEAM, 12.25 DB AZ. GAIN, MAX. AT 236.0 DEG. HORIZ.

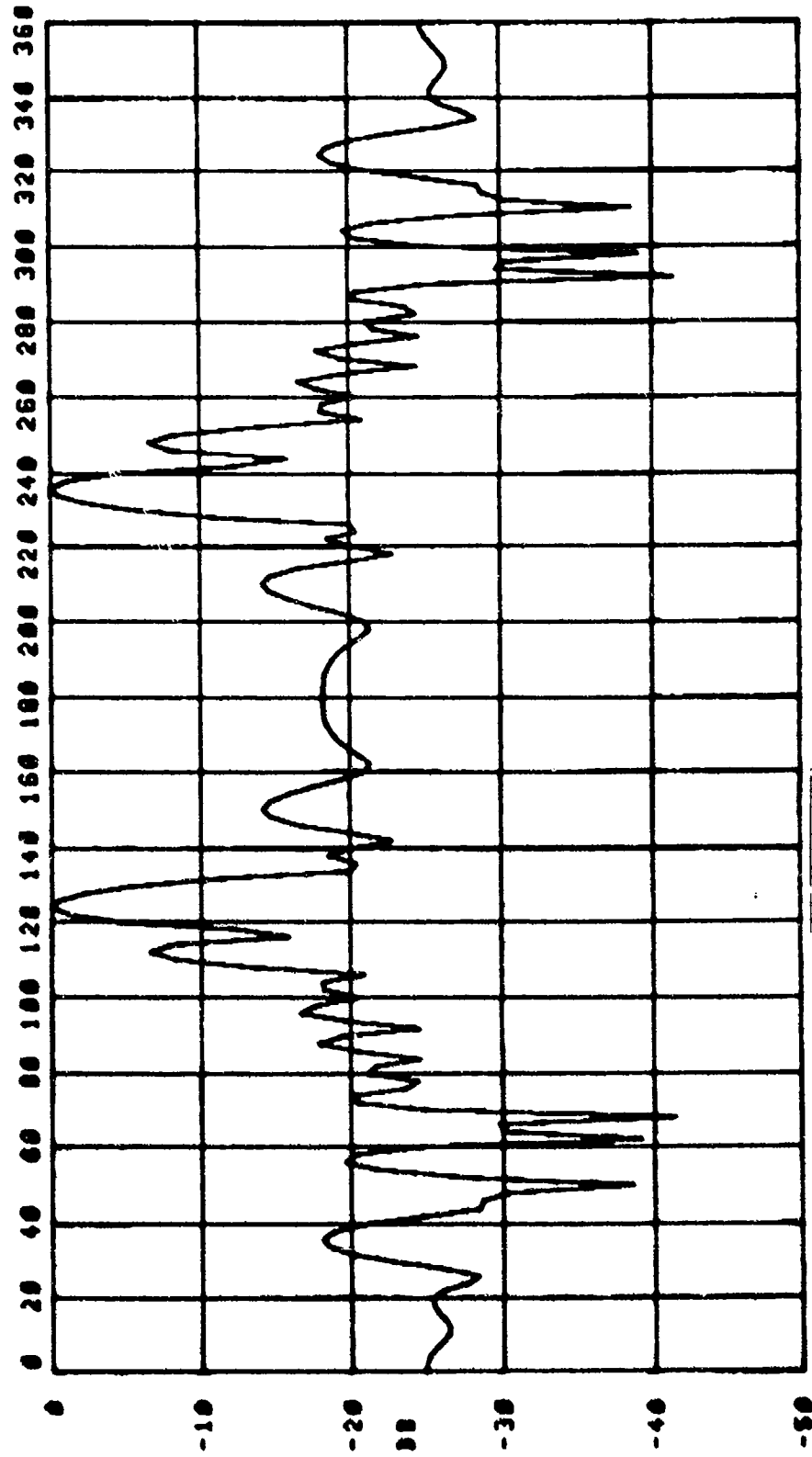


Figure B-47 Theoretical Horizontal Plane Pattern for 16 Element Array at 240 Hz for Data Point 4, 34 Off Broadside Steering. Beamwidth 7.90°, Azimuth Gain 12.2 dB.

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12276 SANDERS BEAM PATTERN PROGRAM (Y.MOGAN) 28-Feb-78 QNTLBP 3.1
 A: SFRM1 ARRAY TUNED TO 300 HZ.
 S: 3333 FT. UNIFORM SPACING.
 S: SAME

DATA POINT 4
 1200 HZ SAMPLING FREQUENCY: DISTORTION PATTERN.
 140.0 HZ. 51 ELEMENTS. -0.17 DB MAX. AC: 52501. SU: 52501. UT:
 50.0 DEG. VERT. RESP. 124.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 4.04 DEG. 3 DB BEAM. 14.77 DB AZ. GAIN. MAX. AT 236.0 DEG. HORIZ.

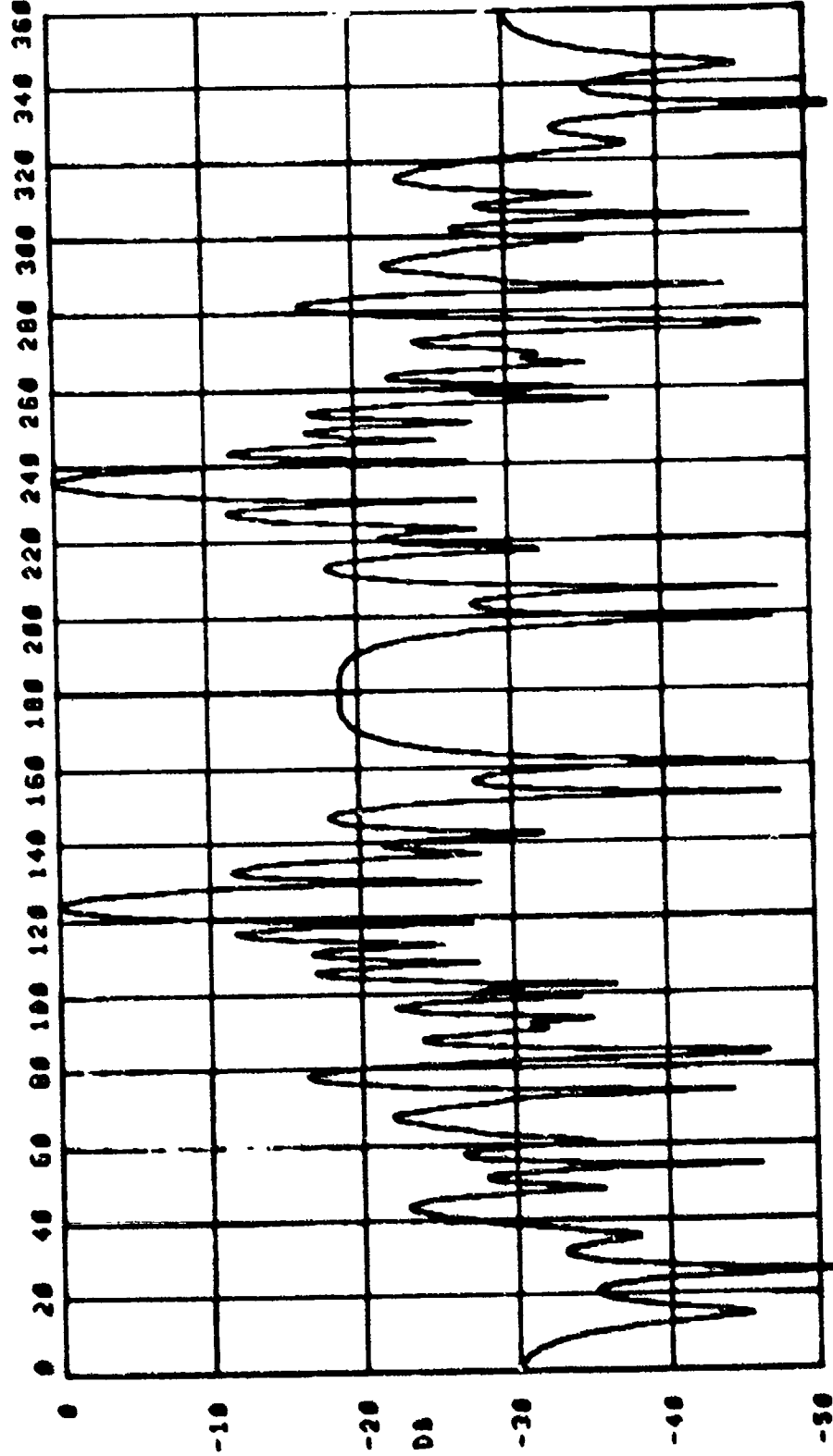


Fig. 2-48 Theoretical Horizontal Plane Pattern for 5 Element
 Array @ 140 Hz for Data Point 4, 34
 Steering. Beamwidth 4.84°, Azimuth Gain 14.7 dB.

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SC279 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 28-FEB-78 ONTLP 2.1
 4: SFEAT AREA) TUNED TO 300 HZ.
 5: 3233 FT. UNIFORM SPACING.
 6: SAME

DATA POINT 4
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 149.0 HZ., 32 ELEMENTS, -0.18 DB MAX., AC:52581, SU:52681, MT:
 90.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 7.79 DEG. 3 DB BEAM, 12.57 DB AZ. GAIN, MAX. AT 236.0 DEG. HORIZ.

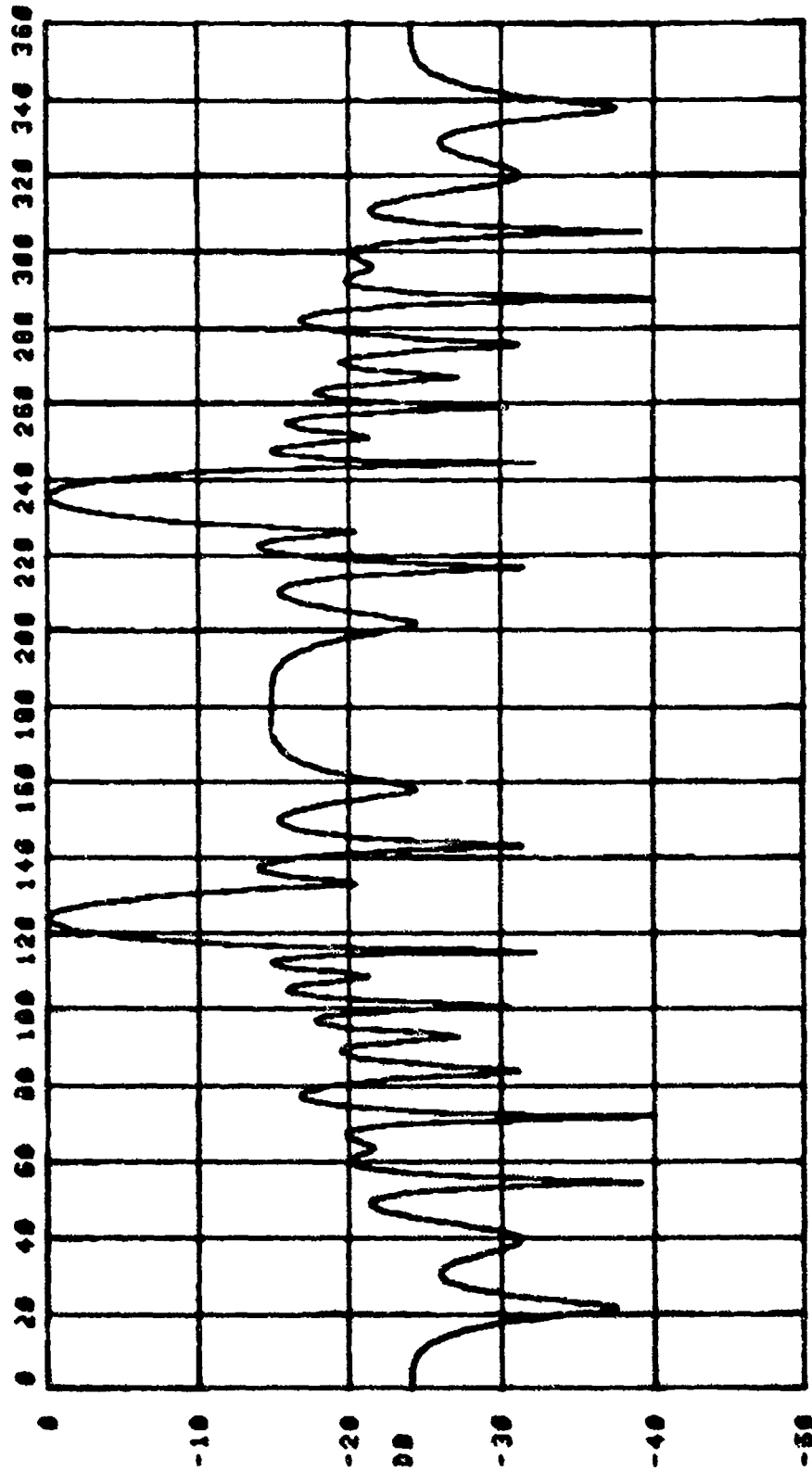


Figure B-49 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 4, 34 Off Broadside Steering. Beamwidth 7.79°, Azimuth Gain 12.6dB.

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SC227A SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 28-Feb-70 ONTLEP 3.1
 A: SFREQ1 AREA1 TUNED TO 300 HZ.
 S: 5.3333 FT. UNIFORM SPACING.
 S: SAFE

DATA POINT 4
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 140.0 HZ., 16 ELEMENTS, -0.21 DB MAX., AC:52501, SU:52501, UT:
 90.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 16.76 DEG. 3 DB BEAM. 9.59 DB AZ. GAIN, MAX. AT 236.0 DEG. HORIZ.

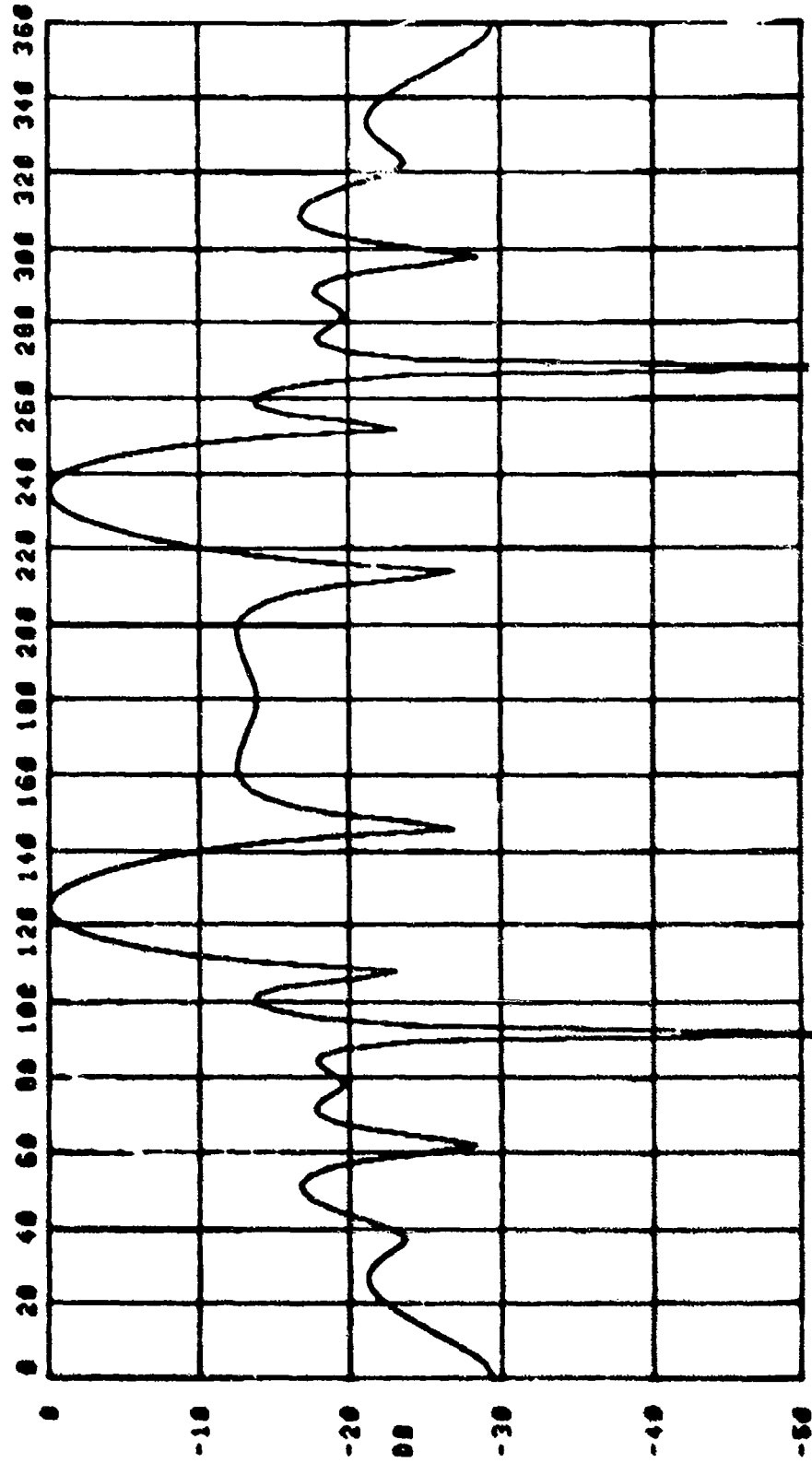


Figure B-50 Theoretical Horizontal Plane Pattern for 16 Element
 Array @ 140 Hz for Data Point 4, Off Broadside
 Steering. Beamwidth 16.76°, Azimuth Gain 9.5 dB.

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54271 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 20-Feb-78 ONTLDP 3.1
 6: SFEW) ARRAY TUNED TO 300 HZ.
 5: 5233 FT. UNIFORM SPACING.
 5: SAME

DATA POINT 4
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 298.0 HZ. 51 ELEMENTS, -0.02 DB MAX., AC:52581, SU:52581, MT:
 90.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
 2.30 DEG. 3 DB BEAM. 17.23 DB AZ. GAIN, MAX. AT 124.0 DEG. HORIZ.

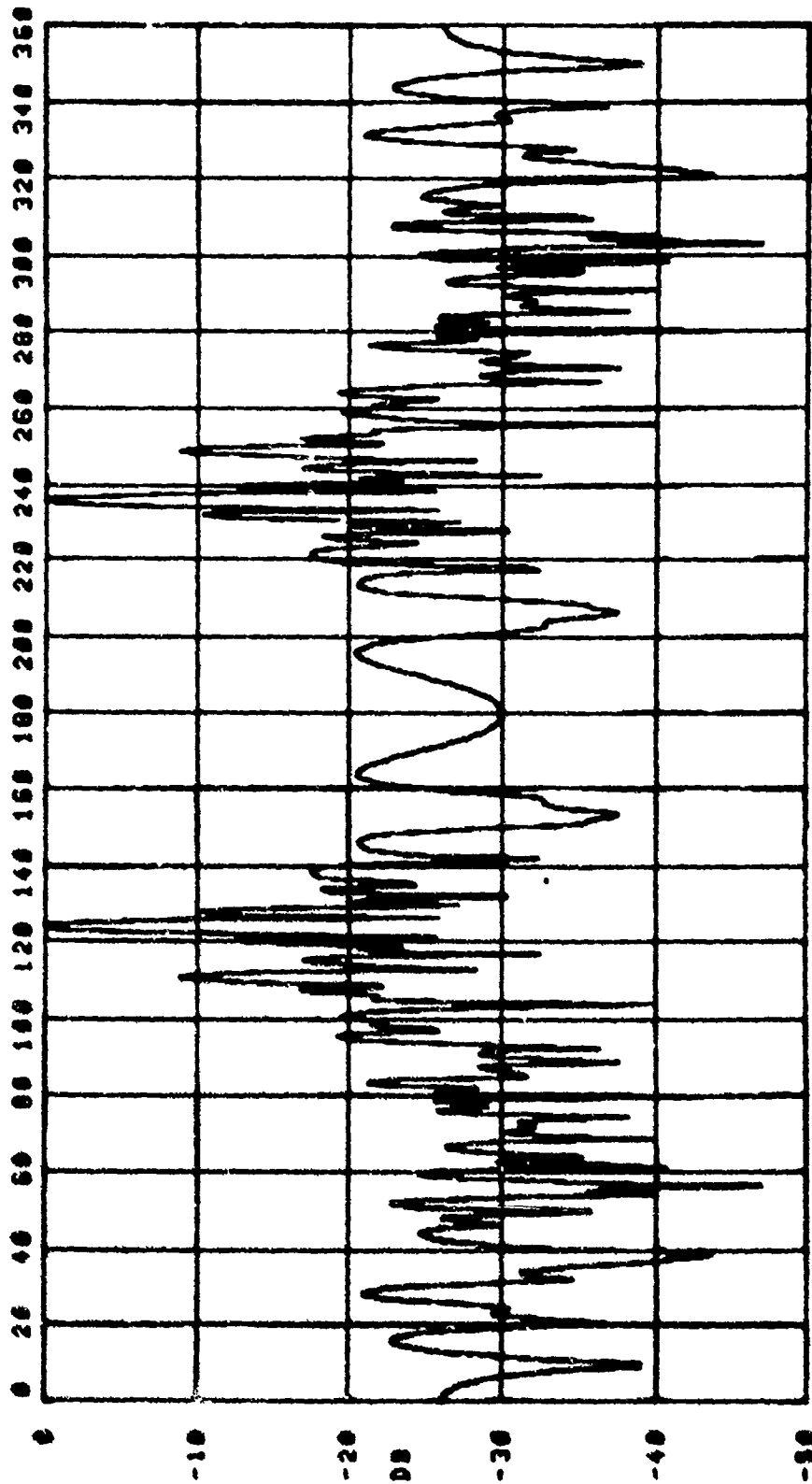


Figure B-5/ Theoretical Horizontal Plane Pattern for 51 Element
 Array at 295 Hz for Data Point 4, 34 Off Broadside
 Steering. Beamwidth 2.30°, Azimuth Gain 17.2 dB.

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5227F SAMBERS BEAM PATTERN PROGRAM (T.MOGAN) 28-FEB-78 ONTLP 3.1
A: SFEAT AREA) TUNED TO 300 HZ.
S: 5.3233 FT. UNIFORM SPACING.
S: SAME

DATA POINT 4
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 32 ELEMENTS, -0.77 DB MAX., AC:52501, SU:52501, UT:
90.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.65 DEG. 3 DB BEAM. 15.19 DB AZ. GAIN, MAX. AT 124.0 DEG. HORIZ.

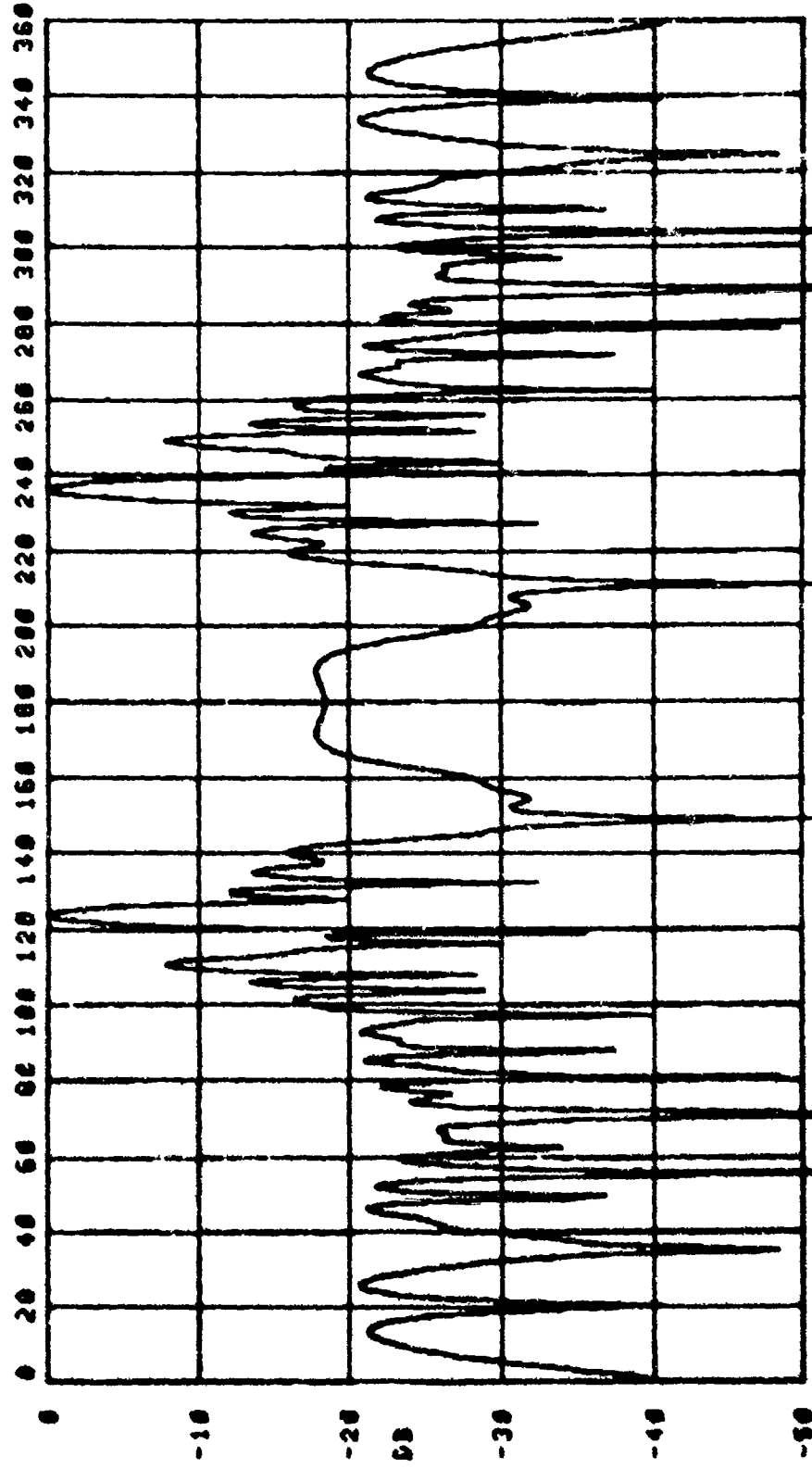


Figure B-52 Theoretical Horizontal Plane Pattern for 32 Element
Array at 295 Hz for Data Point 4, 34 Off Broadside
Steering. Beamwidth 3.65°, Azimuth Gain 15.19 dB.

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S227C SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 20-FEB-70 ONTLEP 3.1
A: SPEAK AREA) TUNED TO 300 HZ.
6.3331 FT. UNIFORM SPACING.
S: SAME

DATA POINT 4
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
16 ELEMENTS, -0.09 DB MAX., AC:52501.SU:52501.WT:
295.0 HZ., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
90.0 DEG. VERT. RESP., 11.04 DB AZ. GAIN, MAX. AT 236.0 DEG. HORIZ.
7.03 DEG. 3 DB BEAM.

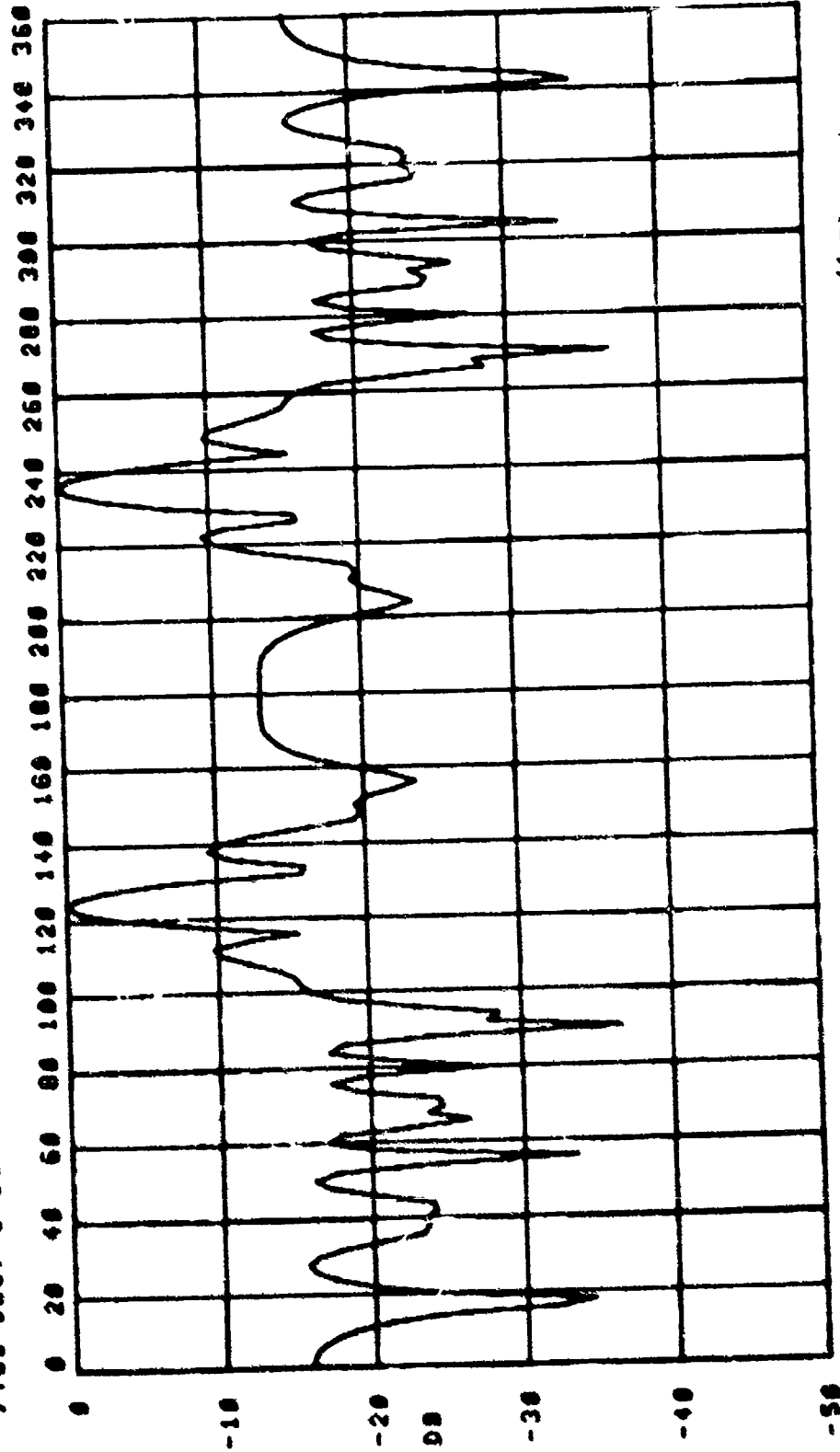


Figure B-53 Theoretical Horizontal Plane Pattern for 16 Element Array @ 295 Hz for Data Point 4, 34 Off Broadside Steering. Beamwidth 7.83, Azimuth Gain 11.8 dB.

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5150 SANDERS BEAM PATTERN PROGRAM (T.MO641) 15-Mar-78 ONTLP 3.1
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
 290.0 HZ. 51 ELEMENTS, -0.81 DB MAX., AC:53461, SU:53461, UT:
 90.0 DEG. VERT. RESP., 139.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 2.95 DEG. 3 DB BEAM, 16.32 DB AZ. GAIN, MAX. AT 139.0 DEG. HORIZ.

DATA POINT 5

1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.

290.0 HZ. 51 ELEMENTS, -0.81 DB MAX., AC:53461, SU:53461, UT:
 90.0 DEG. VERT. RESP., 139.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 2.95 DEG. 3 DB BEAM, 16.32 DB AZ. GAIN, MAX. AT 139.0 DEG. HORIZ.

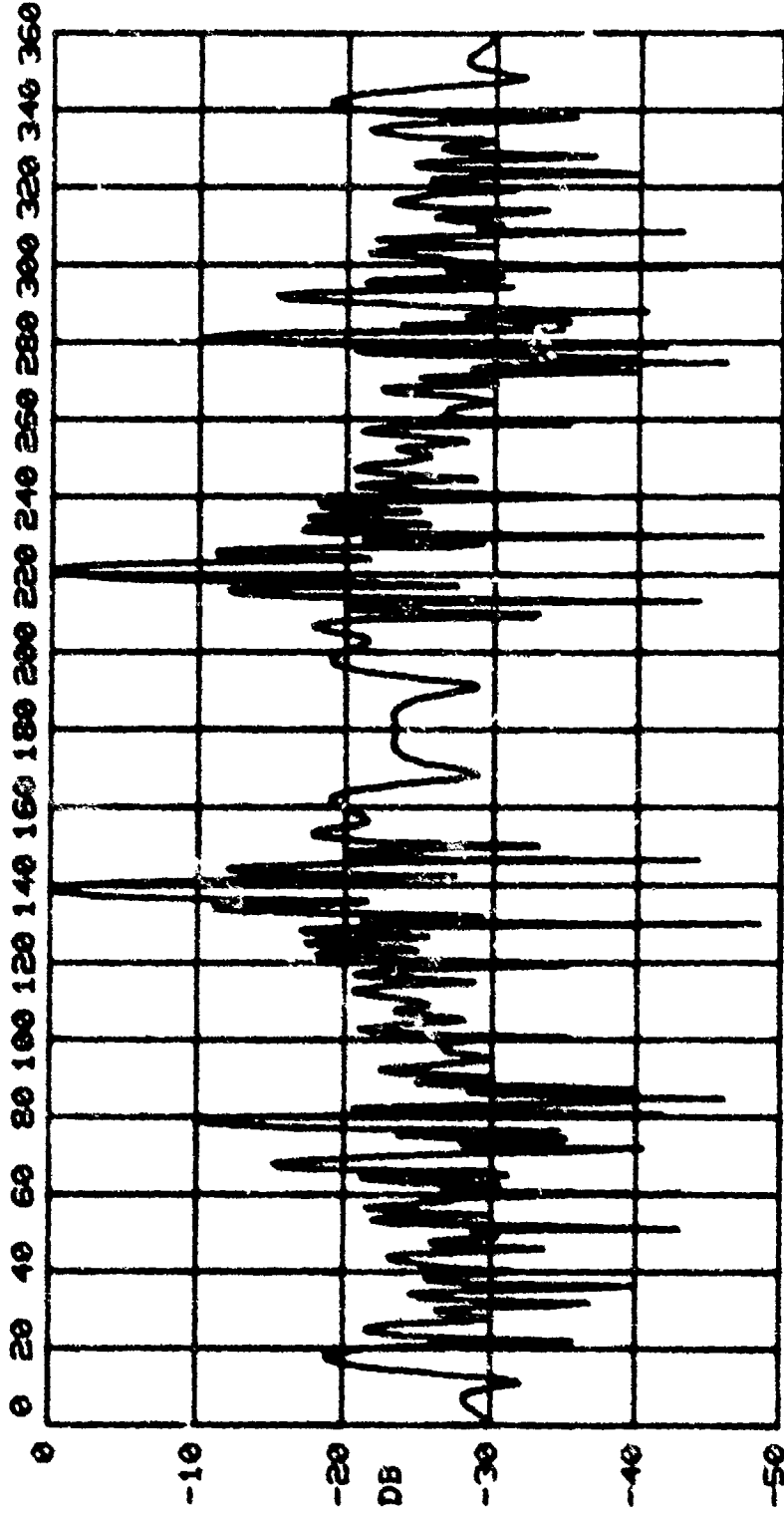


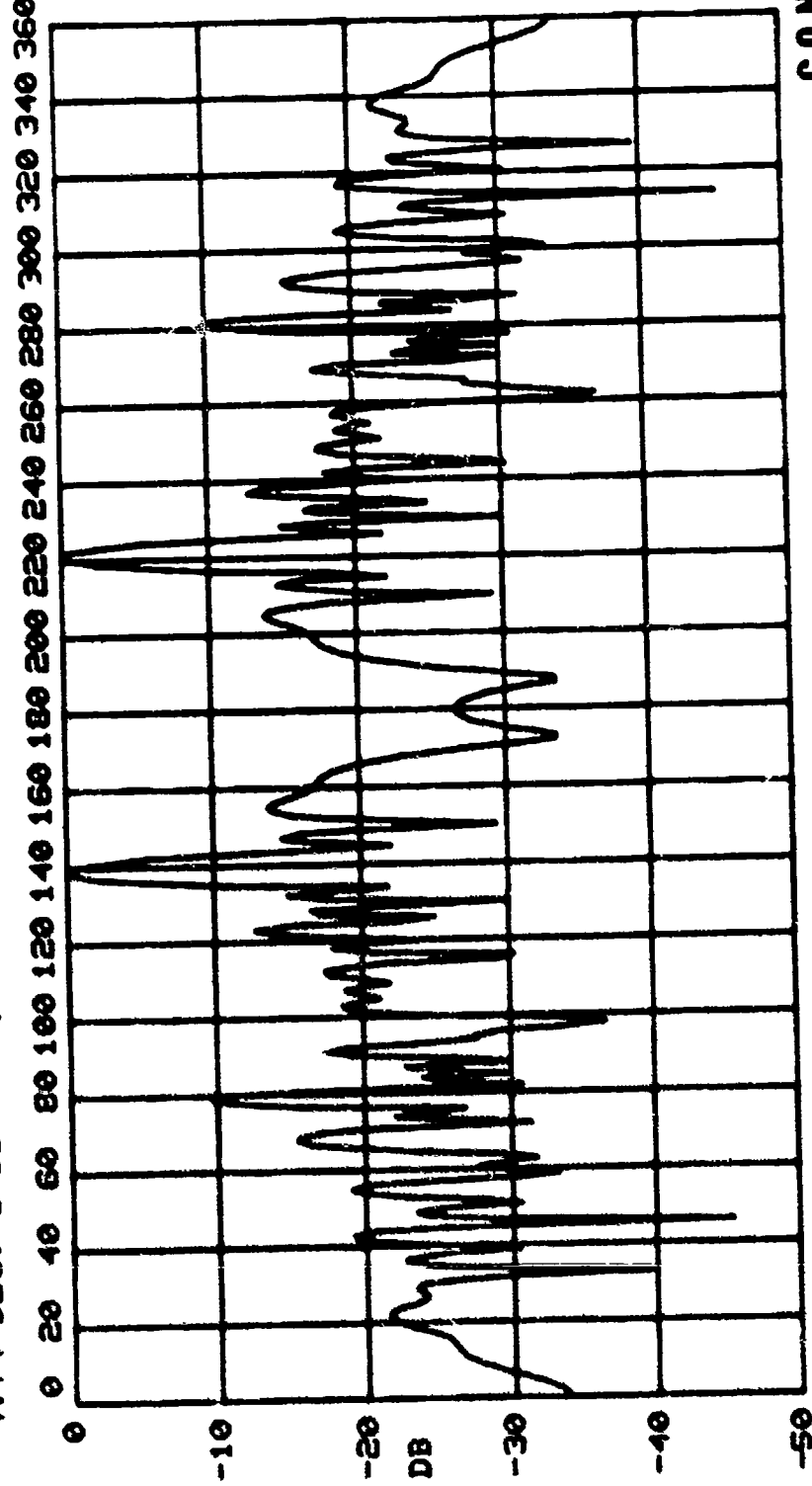
FIGURE 8-54 Theoretical Horizontal Plane Pattern for 51 Element
 Array at 290 HZ for Data Points 5, 49
 Steering: Beamwidth 2.95°, Azimuth Gain 16.32 DB.

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53154 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-Mar-78 QNTLBP 3.1
1: 3000 HZ ARRAY TUNED TO 300 HZ.
2: 8.3333 FT. UNIFORM SPACING.
3: SAME

DATA POINT 5
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 32 ELEMENTS, -0.81 DB MAX., AC:53461, SU:53461, UT:
90.0 DEG. VERT. RESP., 139.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.74 DEG. 3 DB BEAM, 14.37 DB AZ. GAIN, MAX. AT 139.0 DEG. HORIZ.



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Figure B-55 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 290 Hz for Data Point 5, 49 Off Broadside
Steering. Beamwidth 4.74°, Azimuth Gain 14.3 dB.

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S 3152 SAWDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-MAR-78 QNTLBP 3.1
 0: 2.225" ORPA; TUNED TO 300 HZ.
 1: 2.2323 FT. UNIFORM SPACING.
 2: SAME

DATA PRINTS

DATA POINT 3
1.333 HZ SAMPLING FREQUENCY DISTORTS PATTERN.

1500 HZ SAMPLING FREQUENCY DISTORTION FACTOR:
2300.3 HZ., 16 ELEMENTS, -0.89 DB MAX., AC:53461, SU:53461, WT:
90.0 DEG. VERT. RESP., 139.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
10.21 DEG. 3 DB BEAM, 11.28 DB AZ. GAIN, MAX. AT 138.0 DEG. HORIZ.

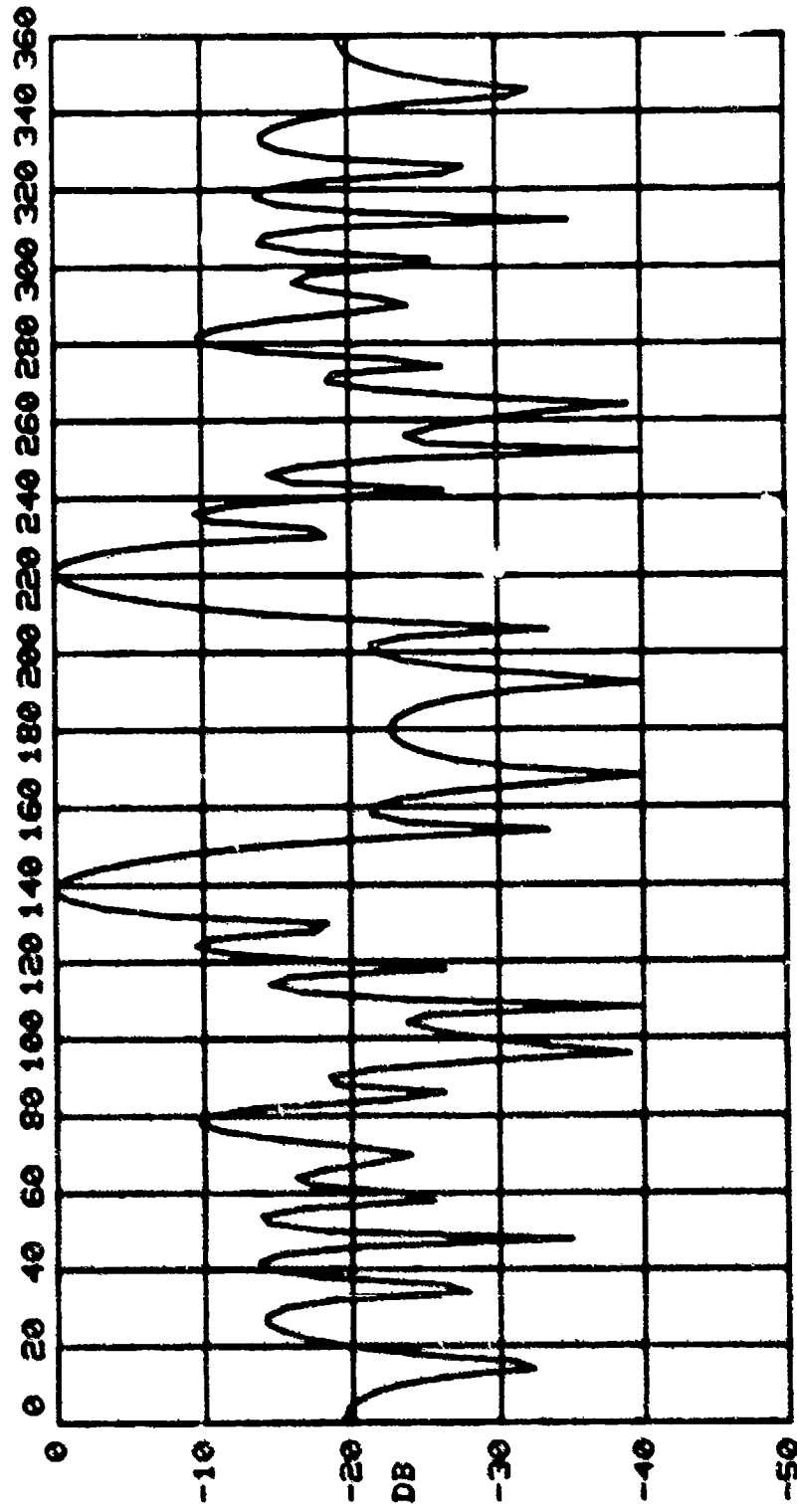


Figure B-56 Theoretical Horizontal Plane Pattern for 16 Element Array at 290 Hz for Data Points 5, 49 Steering. Beamwidth 10.21°, Azimuth Gain 11.2-dB.

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53155 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-Mar-78 ONTLBP 3.1

4: SPREAD ARRAY TUNED TO 300 HZ.

2.3333 FT. UNIFORM SPACING.

3: SAME

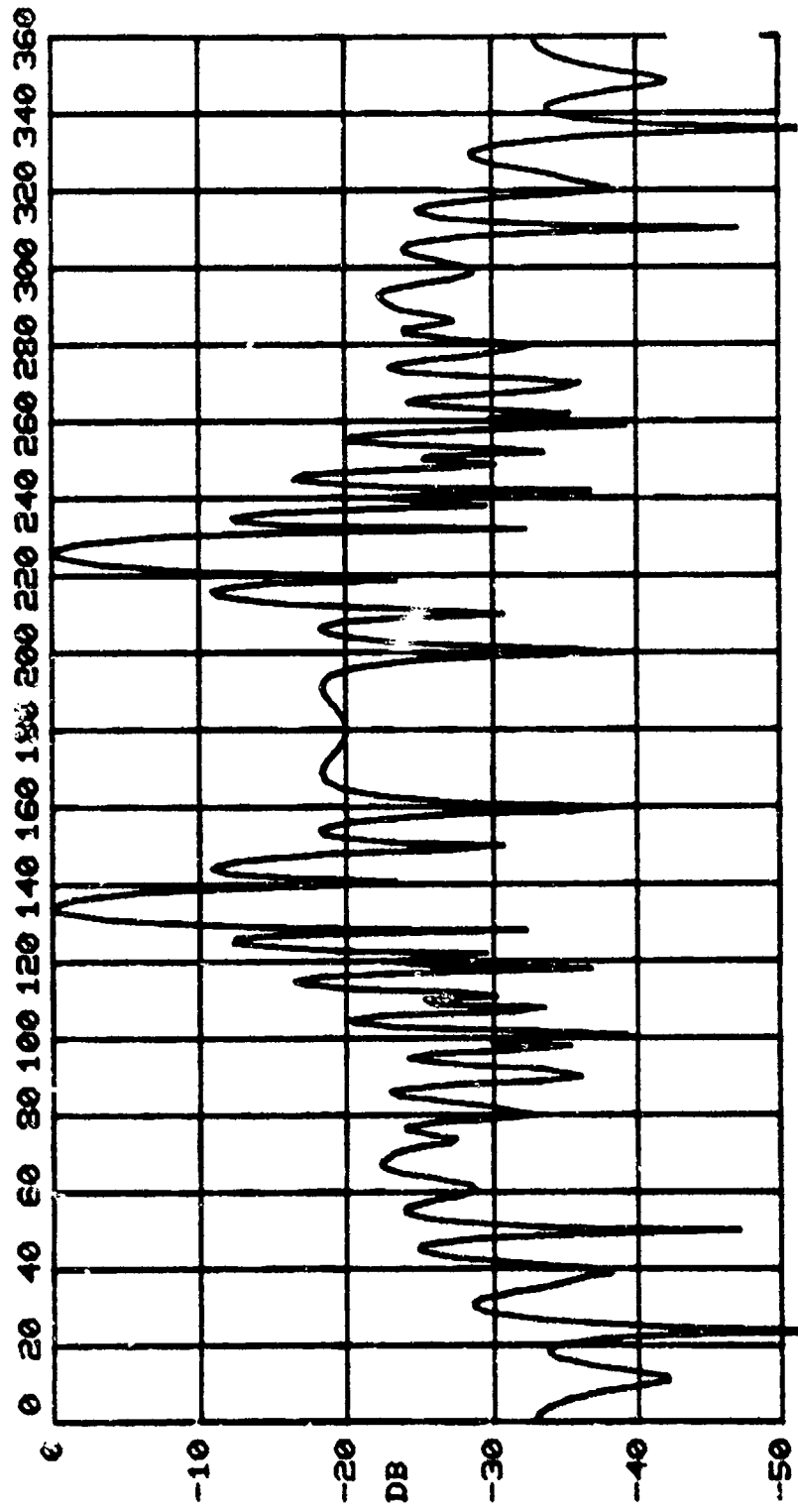
DATA POINT 5

1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.

140.0 HZ., 51 ELEMENTS, -0.18 DB MAX., AC:S3461, SU:S3461, WT:

90.0 DEG. VERT. RESP., 134.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

5.59 DEG. 3 DB BEAM, 14.21 DB AZ. GAIN, MAX. AT 134.0 DEG. HORIZ.



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Figure B-57 Theoretical Horizontal Plane Pattern for 5/Element Array @ 140 Hz for Data Point 5, 49 Off Broadside Steering. Beamwidth 5.59°, Azimuth Gain 14.21 dB.

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53153 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-Mar-78 ONTLBP 3.1
A: SPEAR ARRAY TUNED TO 300 HZ.
B: 9.3333 FT. UNIFORM SPACING.
C: SAME

DATA POINT 5
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 32 ELEMENTS, -0.19 DB MAX., AC: S3461, SU: S3461, UT:
90.0 DEG. VERT. RESP., 134.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
9.01 DEG. 3 DB BEAM, 12.24 DB AZ. GAIN, MAX. AT 134.0 DEG. HORIZ.

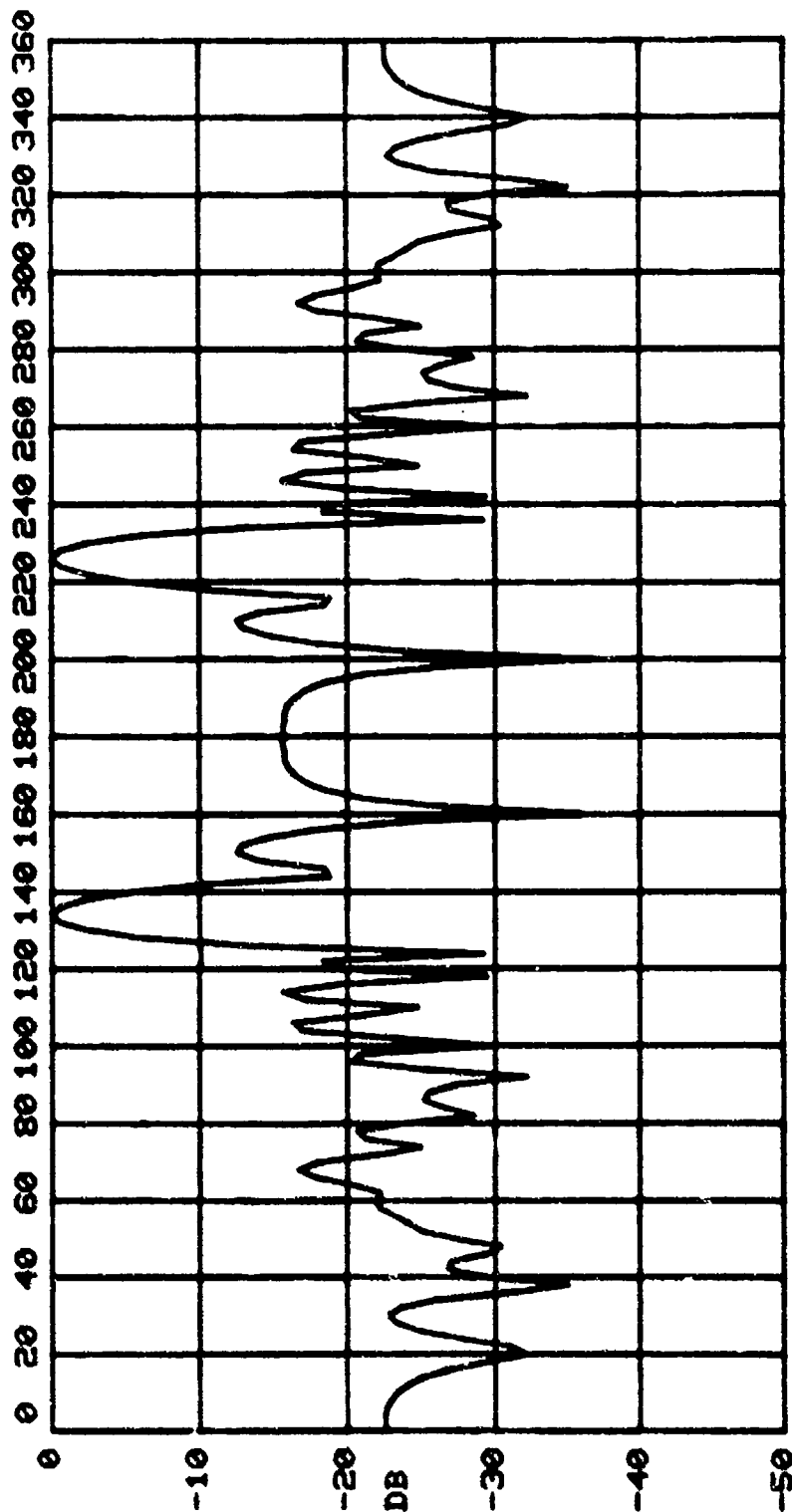


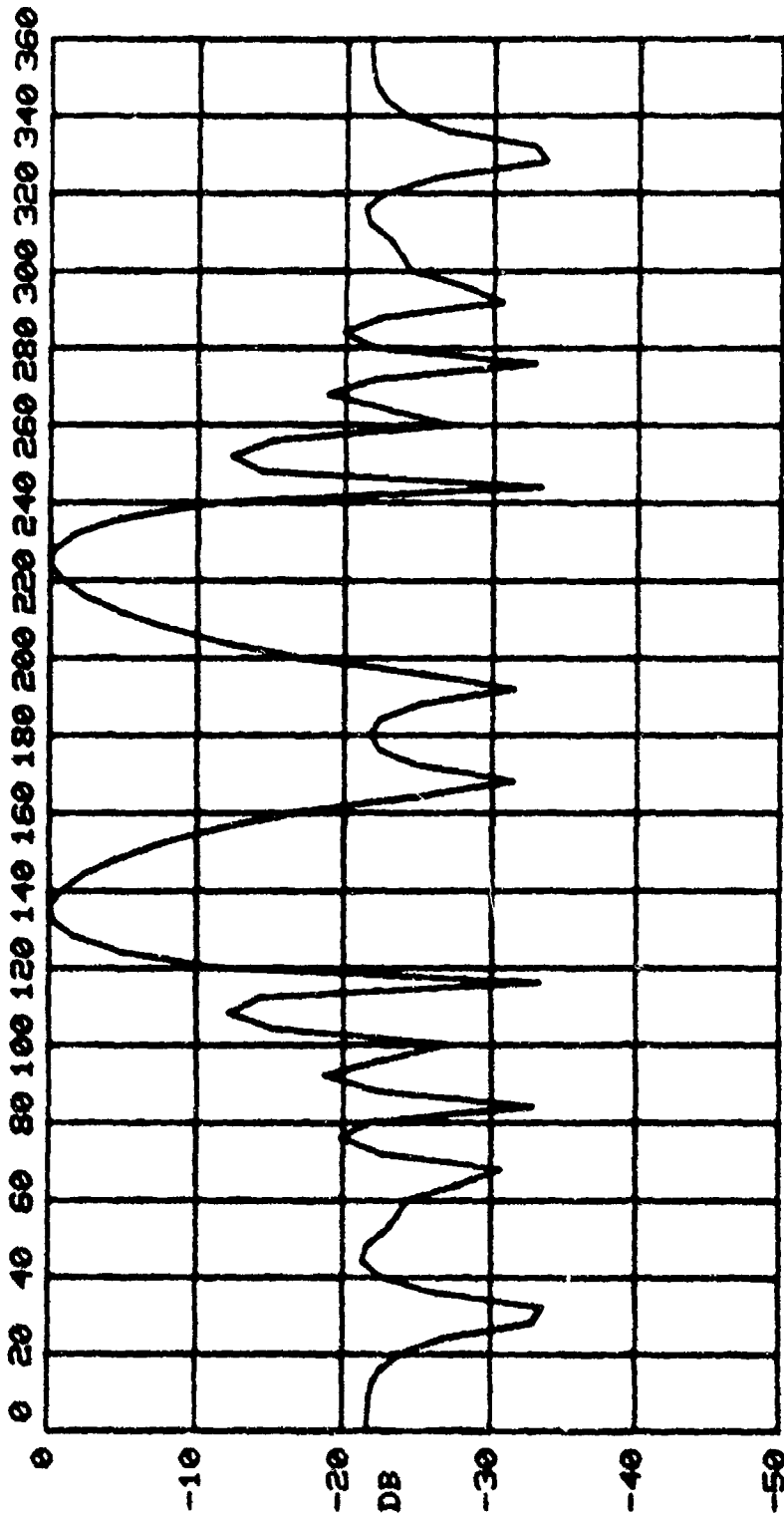
Figure B-58 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 5, 44 Off Broadside Steering. Beamwidth 9.01°, Azimuth Gain 12.2 dB.

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53151 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-Mar-78 ONTLBP 3.1
1: SPODY ARRAY TUNED TO 300 HZ.
S.2323 FT. UNIFORM SPACING.
S: SAME

DATA POINT 5
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.20 DB MAX., AC:53461, SU:53461, UT:
90.0 DEG. VERT. RESP., 134.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
19.76 DEG. 3 DB BEAM, 9.20 DB AZ. GAIN, MAX. AT 136.0 DEG. HORIZ.



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Figure B-59 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 140 Hz for Data Points 5, 4, 0 Off Broadside
Steering. Beamwidth 19.76°, Azimuth Gain 9.2 dB.

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54026 SAIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLP 3.1
: 3000 HZ. ARRAY TUNED TO 300 HZ.
: 2.1253 FT. UNIFORM SPACING.
: 54026

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 51 ELEMENTS, -0.79 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 106.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.01 DEG. 3 DB BEAM, 17.49 DB AZ. GAIN, MAX. AT 106.0 DEG. HORIZ.

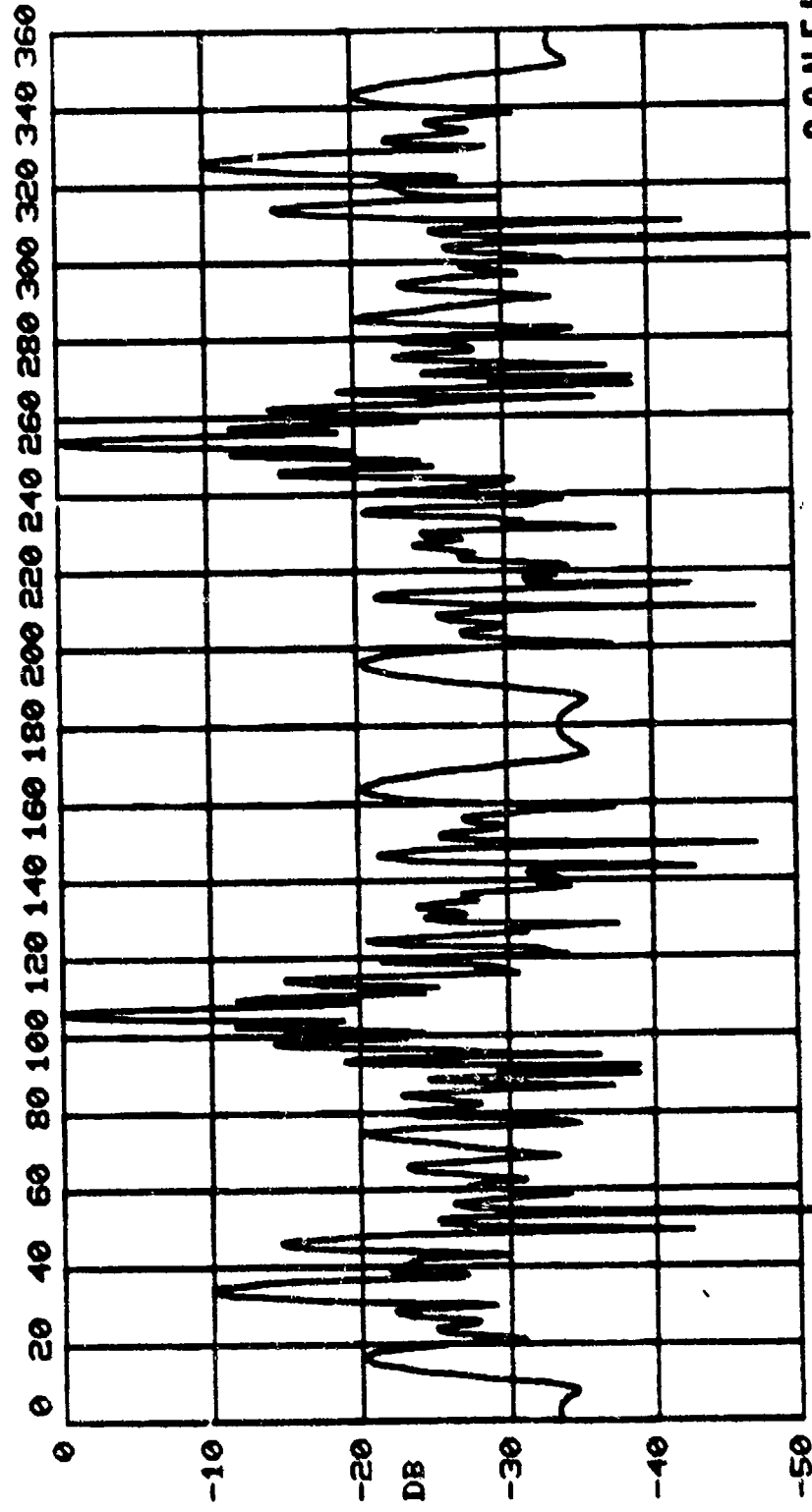


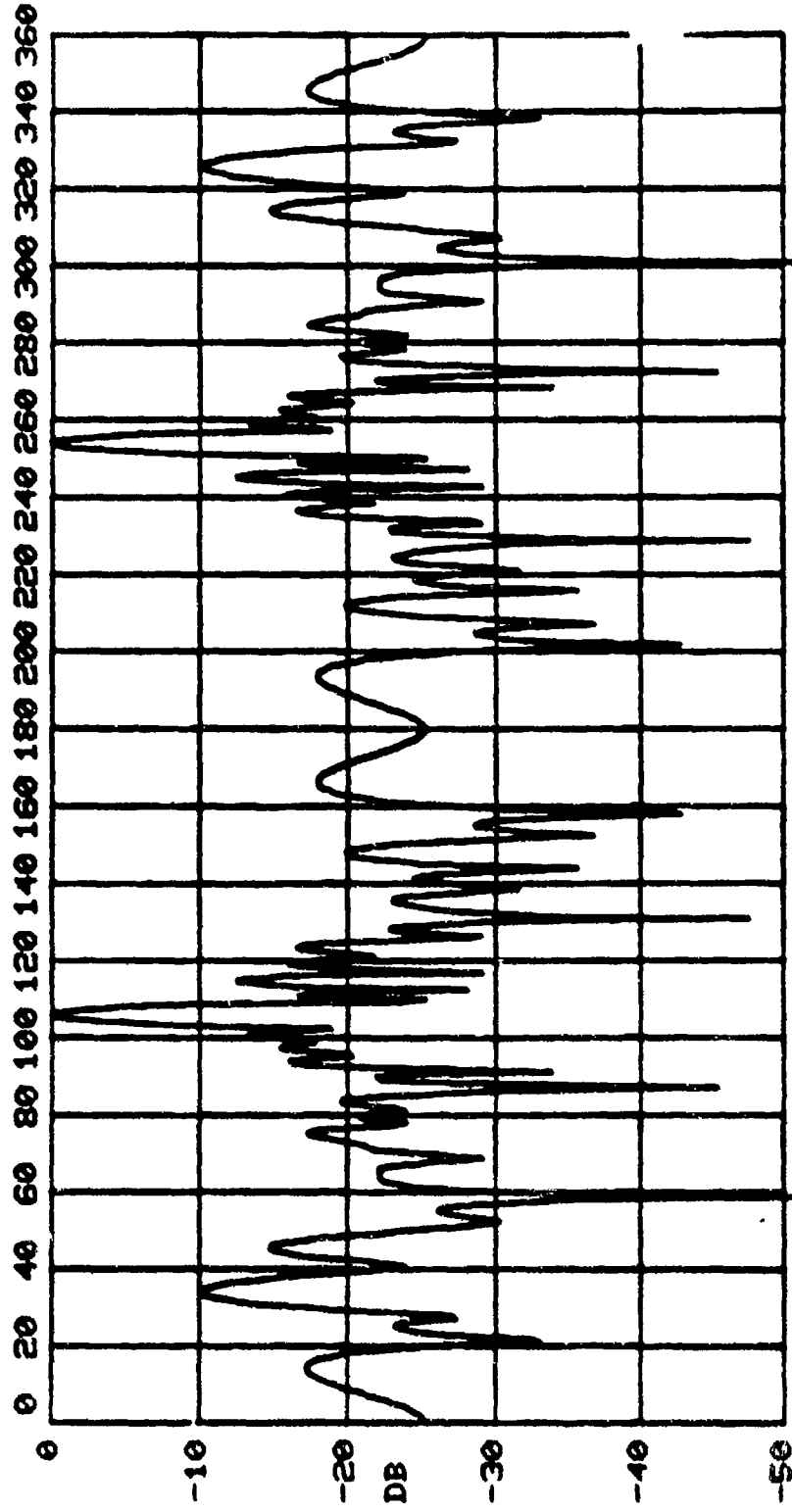
Figure B-60 Theoretical Horizontal Plane Pattern for 51 Element
Array @ 290 Hz for Data Point 6, 16 Off Broadside
Steering. Beamwidth 2.01°, Azimuth Gain 17.4 dB.

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34024 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLP 3.1
: 3000 HZ. ARRAY TUNED TO 300 HZ.
: 1.1223 FT. UNIFORM SPACING.
: 3000

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
299.3 HZ., 32 ELEMENTS, -0.80 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 106.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.24 DEG. 3 DB BEAM, 15.34 DB AZ. GAIN, MAX. AT 106.0 DEG. HORIZ.



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Figure B-6/ Theoretical Horizontal Plane Pattern for 32 Element
Array at 290 Hz for Data Point 6, 16 Off Broadside
Steering. Beamwidth 3.24°, Azimuth Gain 15.3 dB.

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54212 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLEP 3.1
1: 300 HZ. ARRAY TUNED TO 300 HZ.
2: 3.3333 FT. UNIFORM SPACING.
3: SAME

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 16 ELEMENTS, -0.61 DB MAX., AC:S2581, SU:S2581, UT:
90.0 DEG. VERT. RESP., 106.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.82 DEG. 3 DB BEAM, 12.53 DB AZ. GAIN, MAX. AT 105.0 DEG. HORIZ.

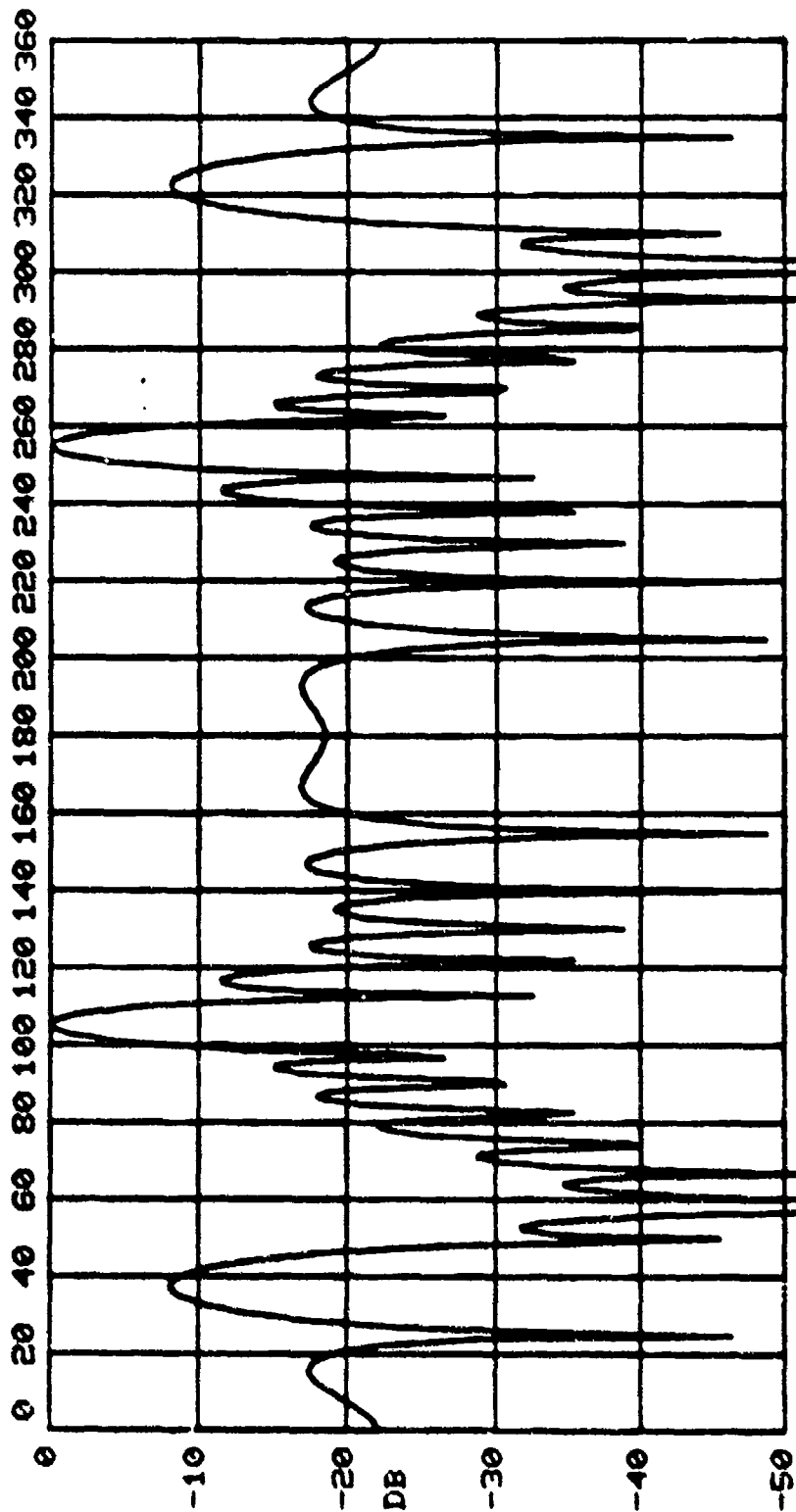


Figure B-62 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 290 Hz for Data Point 6, 16 Off Broadside
Steering. Beamwidth 6.82°, Azimuth Gain 12.5 dB.

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34035 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 QNTLBP 3.1
: : 3000 HZ. ARRAY TUNED TO 300 HZ.
: : 3.333 FT. UNIFORM SPACING.
: : SAME

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 51 ELEMENTS, -0.19 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 104.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.16 DEG. 3 DB BEAM, 15.50 DB AZ. GAIN, MAX. AT 256.0 DEG. HORIZ.

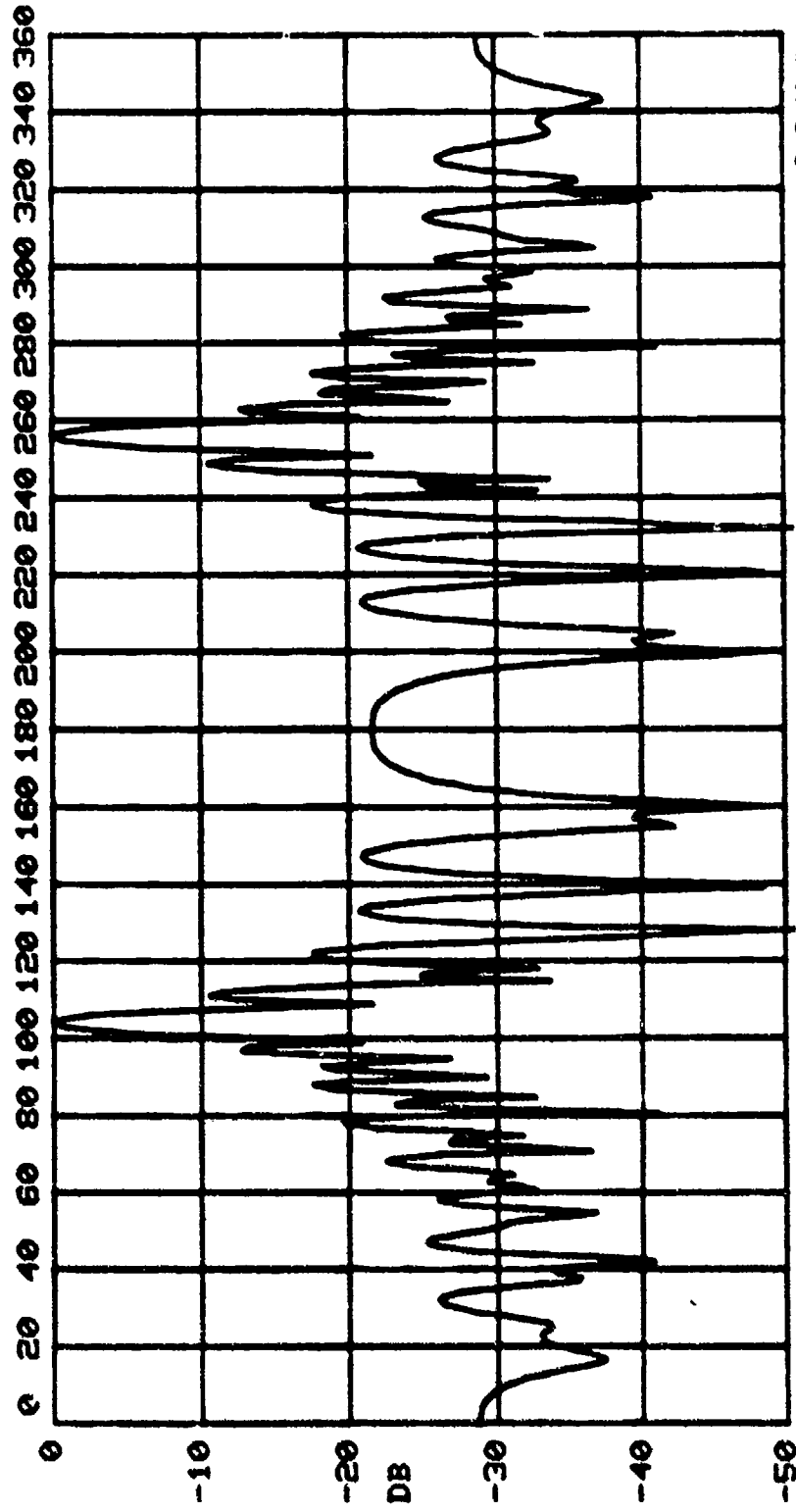


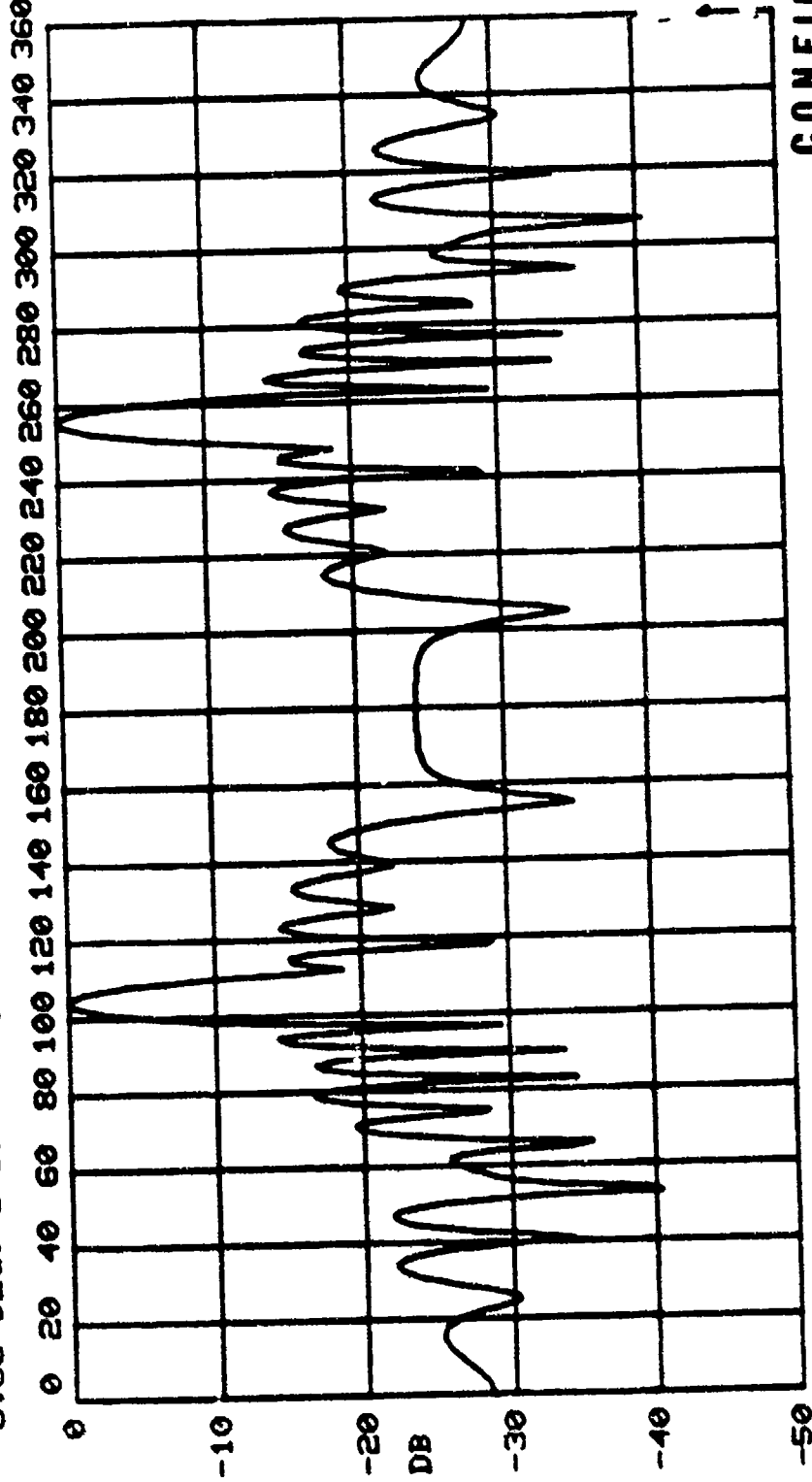
Figure B-63 Theoretical Horizontal Plane Pattern for 5/Element
Array @ 140 Hz for Data Point 6, 1/4 Off Broadside
Steering. Beamwidth 4.16°, Azimuth Gain 15.5 dB.

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14022 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLP 3.1
1: 30000 ARRAY TUNED TO 300 HZ.
2: 3.0223 FT. UNIFORM SPACING.
3: SAME

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 32 ELEMENTS, -0.19 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 104.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.66 DEG. 3 DB BEAM, 13.49 DB AZ. GAIN, MAX. AT 256.0 DEG. HORIZ.



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Figure B-64 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 6, 1/4 Off Broadside Steering. Beamwidth 6.66°, Azimuth Gain 13.4 dB.

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64021 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBF 3.1
** 6523: ARRAY TUNED TO 300 HZ.
3.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.17 DB MAX., AC:S2581, SU:S2581, UT:
90.0 DEG. VERT. RESP., 104.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
14.17 DEG. 3 DB BEAM, 10.45 DB AZ. GAIN, MAX. AT 256.0 DEG. HORIZ.

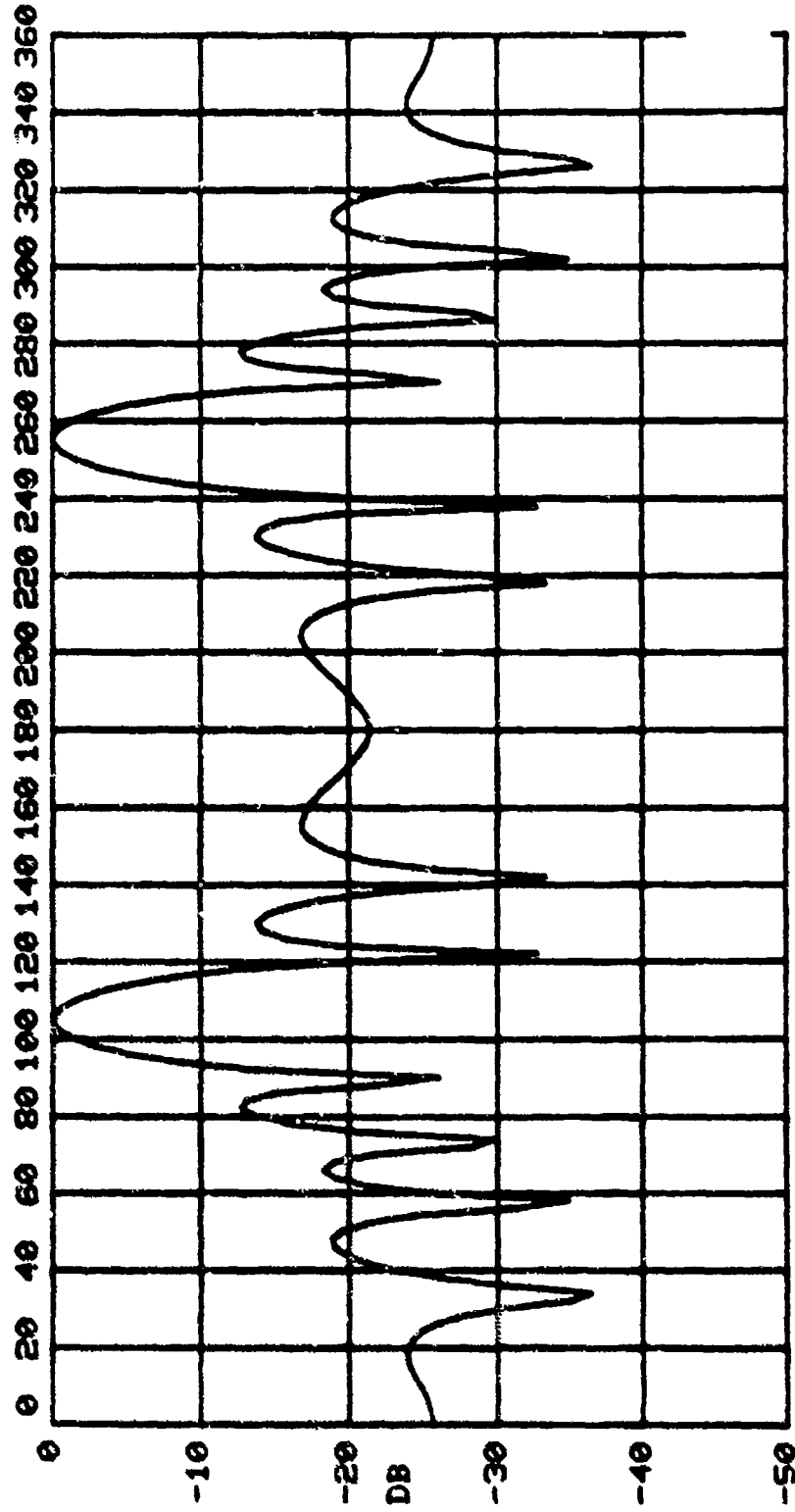


Figure B-65 Theoretical Horizontal Plane Pattern for 16 Element Array @ 140 Hz for Data Point 6, 14 Off Broadside Steering. Beamwidth 14.17°, Azimuth Gain 10.4 dB.

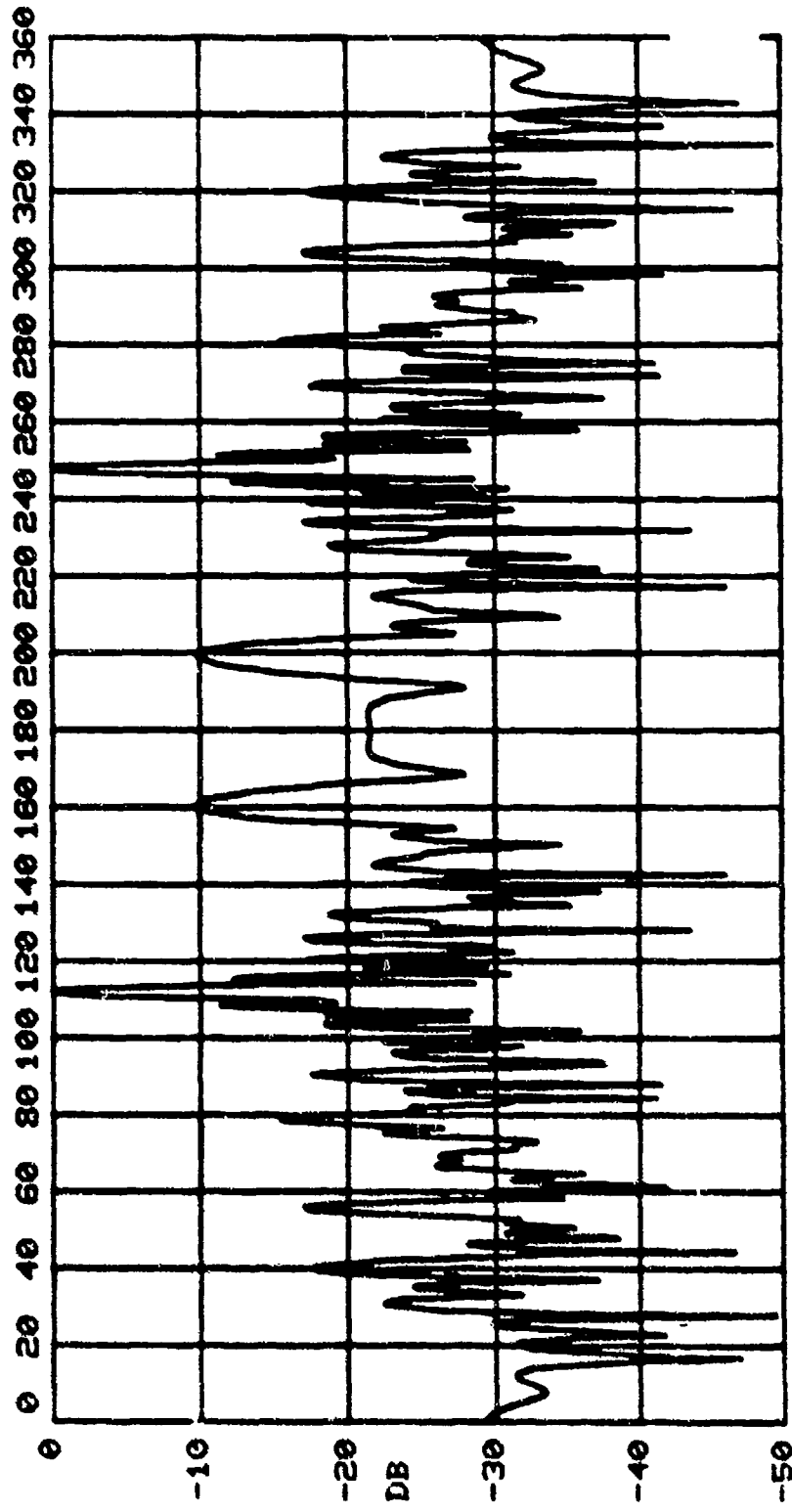
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SAIDIE SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY TUNED TO 300 HZ.
1.1223 FT. UNIFORM SPACING.
1.1223

DATA POINT 7

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
200.0 HZ., 51 ELEMENTS, -0.79 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 112.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.10 DEG. 3 DB BEAM, 17.06 DB AZ. GAIN, MAX. AT 112.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-66 Theoretical Horizontal Plane Pattern for 51 Element
Array at 290 Hz for Data Point 7, 22 Off Broadside
Steering. Beamwidth 2.10°, Azimuth Gain 17.0 dB.

CONFIDENTIAL

14028 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
14029 ARRAY TUNED TO 300 HZ.
14030 32 ELEMENTS, -0.81 DB MAX., AC:52581, SU:52581, UT:
14031 90.0 DEG. VERT. RESP., 111.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
14032 3.36 DEG. 3 DB BEAM, 14.70 DB AZ. GAIN, MAX. AT 111.5 DEG. HORIZ.

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 32 ELEMENTS, -0.81 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 111.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.36 DEG. 3 DB BEAM, 14.70 DB AZ. GAIN, MAX. AT 111.5 DEG. HORIZ.

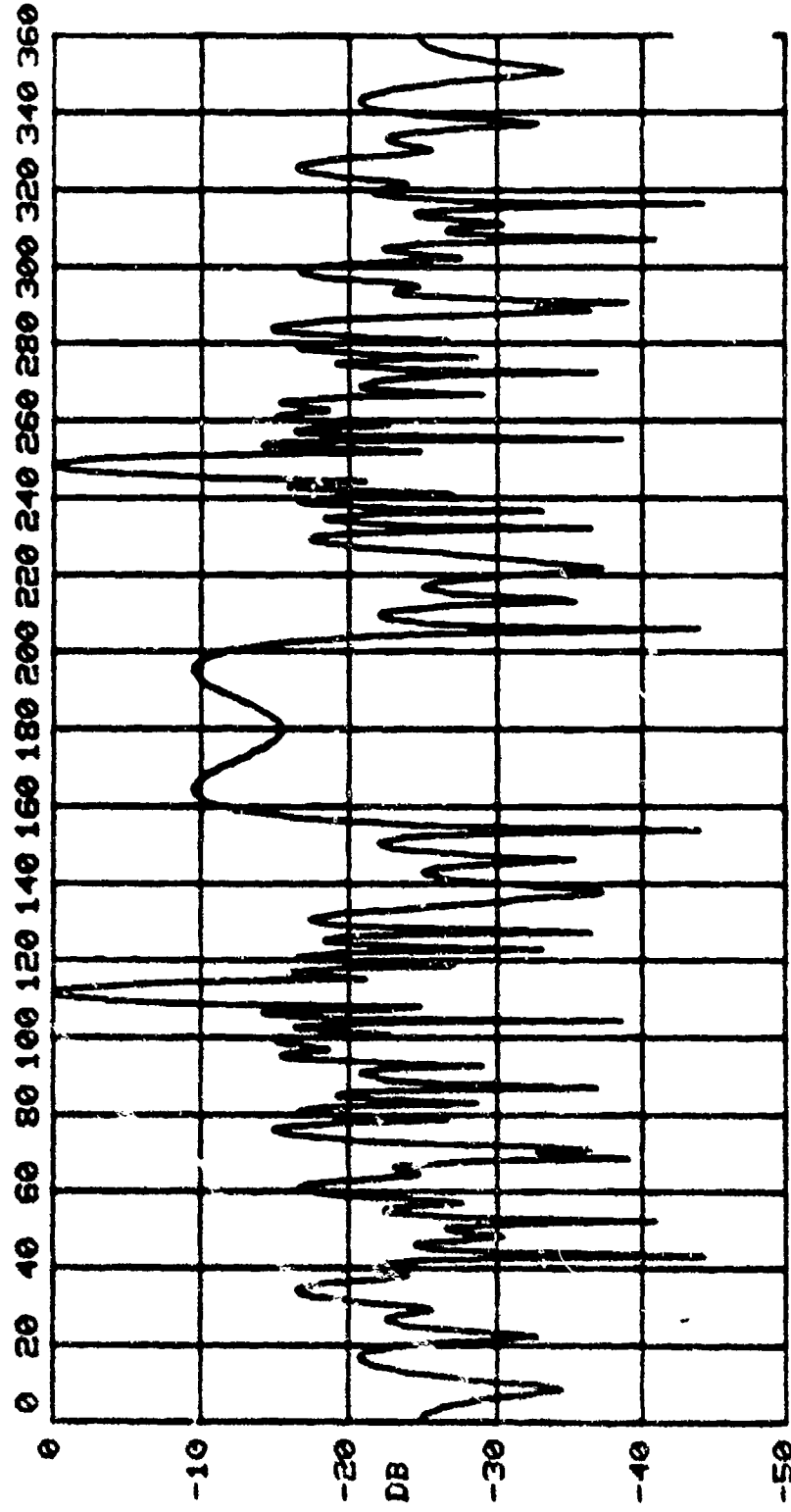


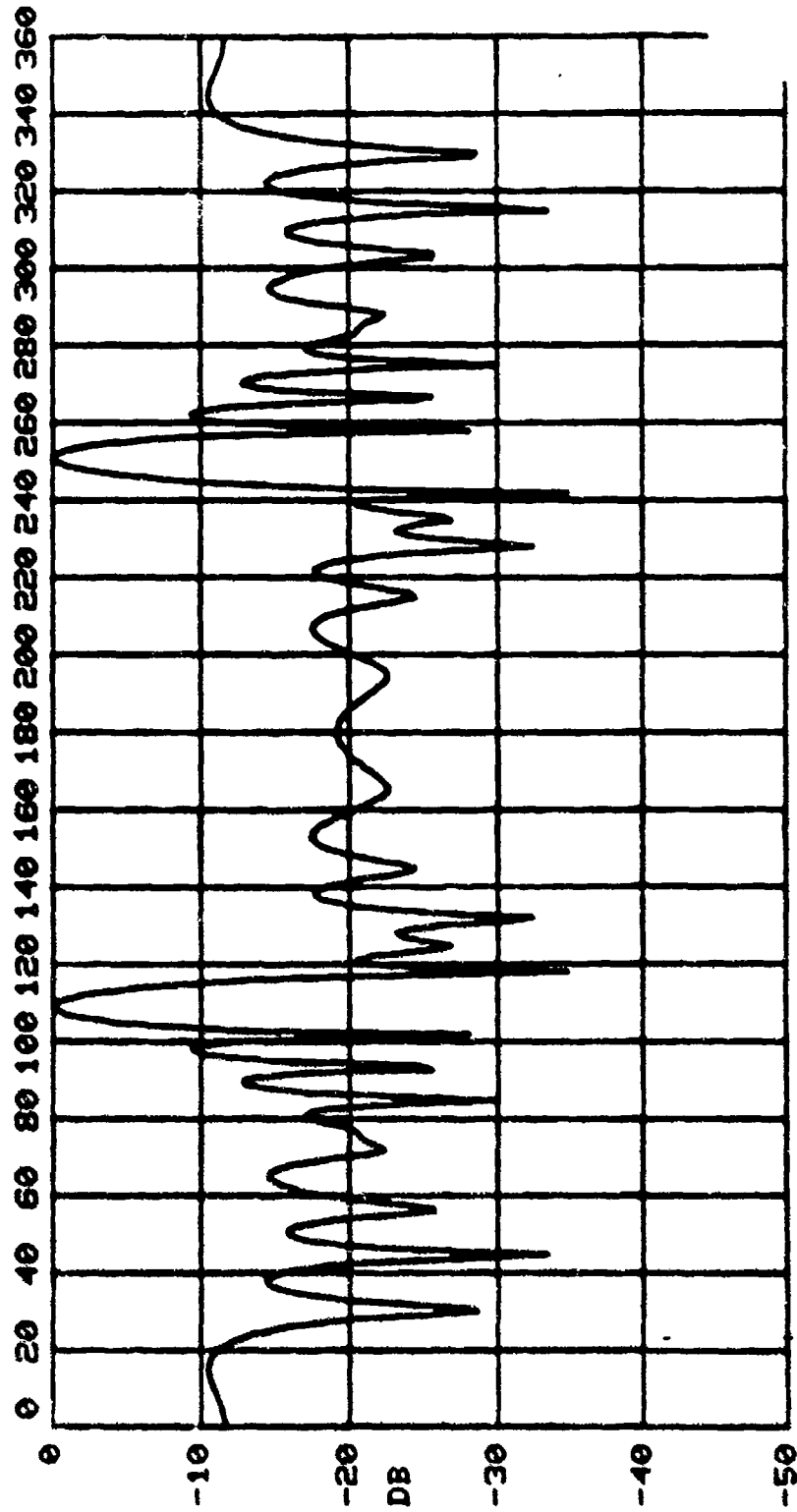
Figure 2-67 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 290 Hz for Data Point 7, 21.5 Off Broadside
Steering. Beamwidth 3.36°, Azimuth Gain 14.7 dB.

CONFIDENTIAL

CONFIDENTIAL

140222 SAUNDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLBP 3.1
... 1000 HZ. TUNED TO 300 HZ.
... 1000 FT. UNIFORM SPACING.
... 1000

DATA POINT 7
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
200.0 HZ., 16 ELEMENTS, -0.84 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 109.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.01 DEG. 3 DB BEAM, 12.04 DB AZ. GAIN, MAX. AT 109.0 DEG. HORIZ.



CONFIDENTIAL

Figure 2-68 Theoretical Horizontal Plane Pattern for 16 Element
Array at 290 Hz for Data Point 7, 19 Off Broadside
Steering. Beamwidth 7.01°, Azimuth Gain 12.0 dB.

CONFIDENTIAL

S4020 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
: 3000 HZ. ARRAY TUNED TO 300 HZ.
: 3000 FT. UNIFORM SPACING.
: SAME

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ. 51 ELEMENTS, -0.18 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 126.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.98 DEG. 3 DB BEAM, 14.73 DB AZ. GAIN, MAX. AT 126.0 DEG. HORIZ.

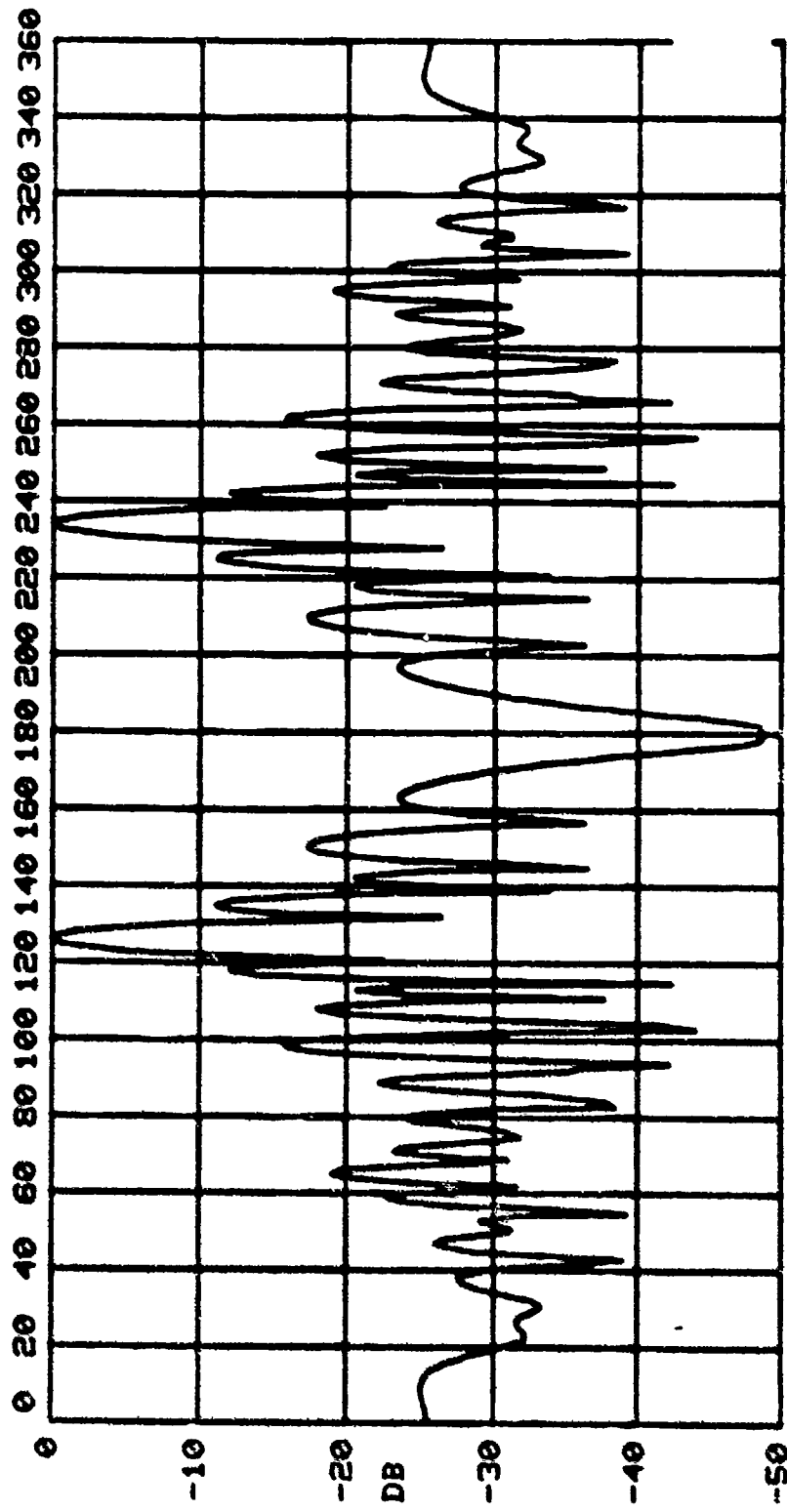


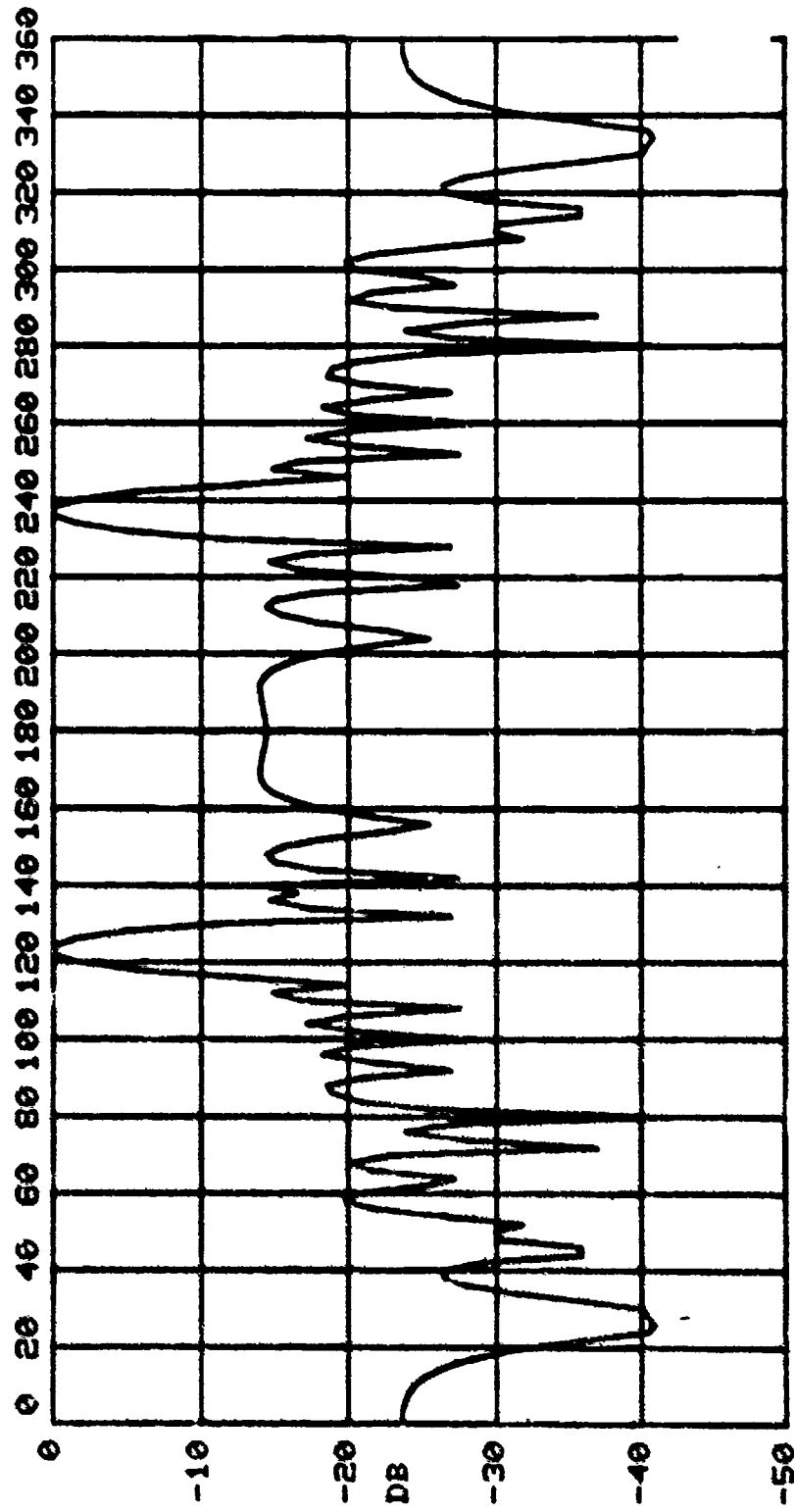
Figure E-69 Theoretical Horizontal Plane Pattern for 51 Element
Array @ 140 Hz for Data Point 7, 36 Off Broadside
Steering. Beamwidth 4.98°, Azimuth Gain 14.7 dB.

CONFIDENTIAL

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54024 SAUNDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
: 00000 HZ. TUNED TO 300 HZ.
: 0.0000 FT. UNIFORM SPACING.
: 0.0000

DATA POINT 7
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 32 ELEMENTS, -0.35 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 123.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.99 DEG. 3 DB BEAM, 12.55 DB AZ. GPIN, MAX. AT 122.0 DEG. HORIZ.



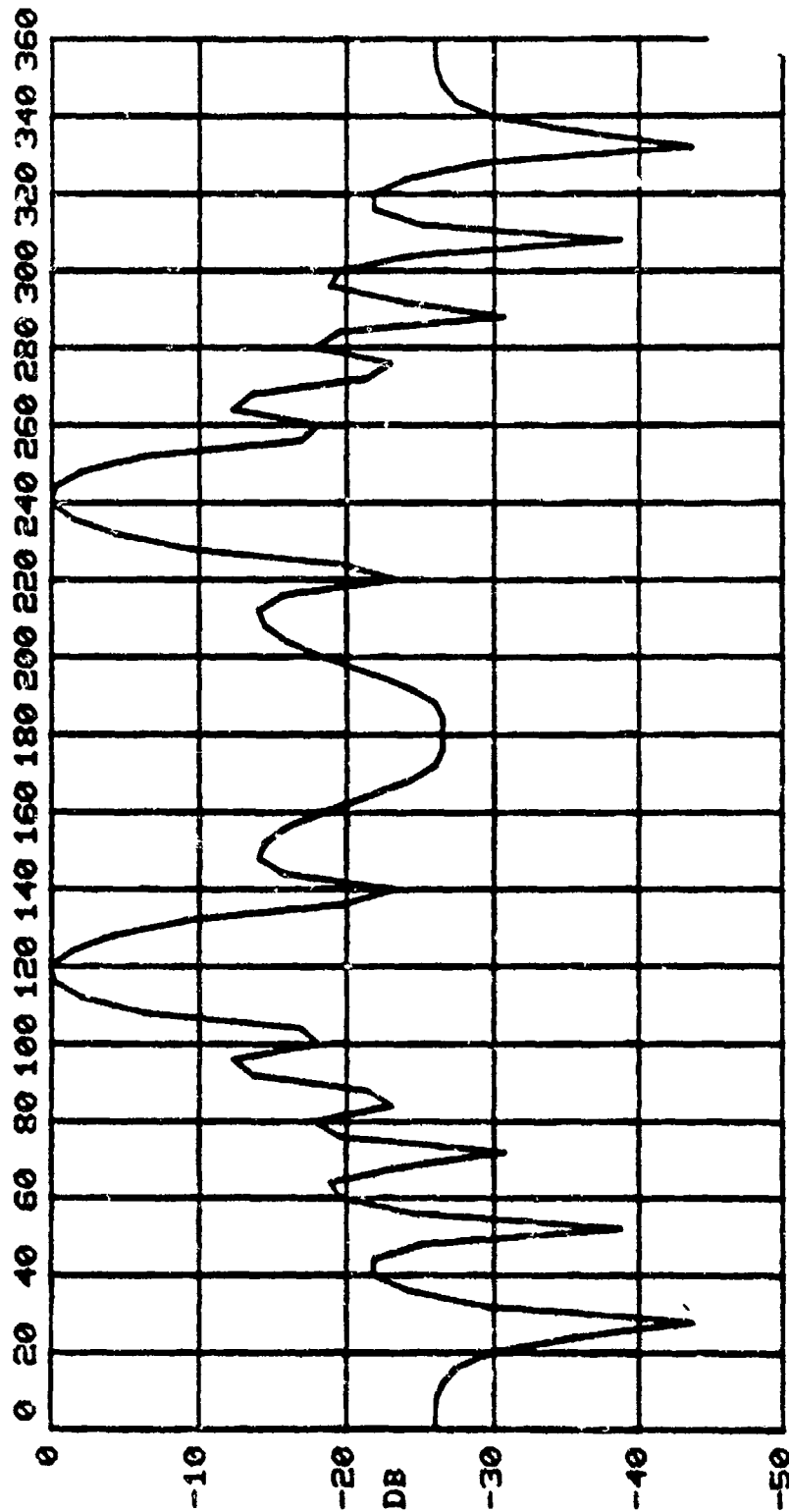
CONFIDENTIAL

Figure 8-70 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 140 HZ for Data Point 7, 33 Off Broadside
Steering. Beamwidth 7.99°, Azimuth Gain 12.5 dB.

CONFIDENTIAL

64027 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLBP 3.1
A: VERT. ARRAY TUNED TO 300 HZ.
E: 3223 FT. UNIFORM SPACING.
C: SAME

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.17 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 118.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
15.98 DEG. 3 DB BEAM, 10.00 DB AZ. GAIN, MAX. AT 120.0 DEG. HORIZ.



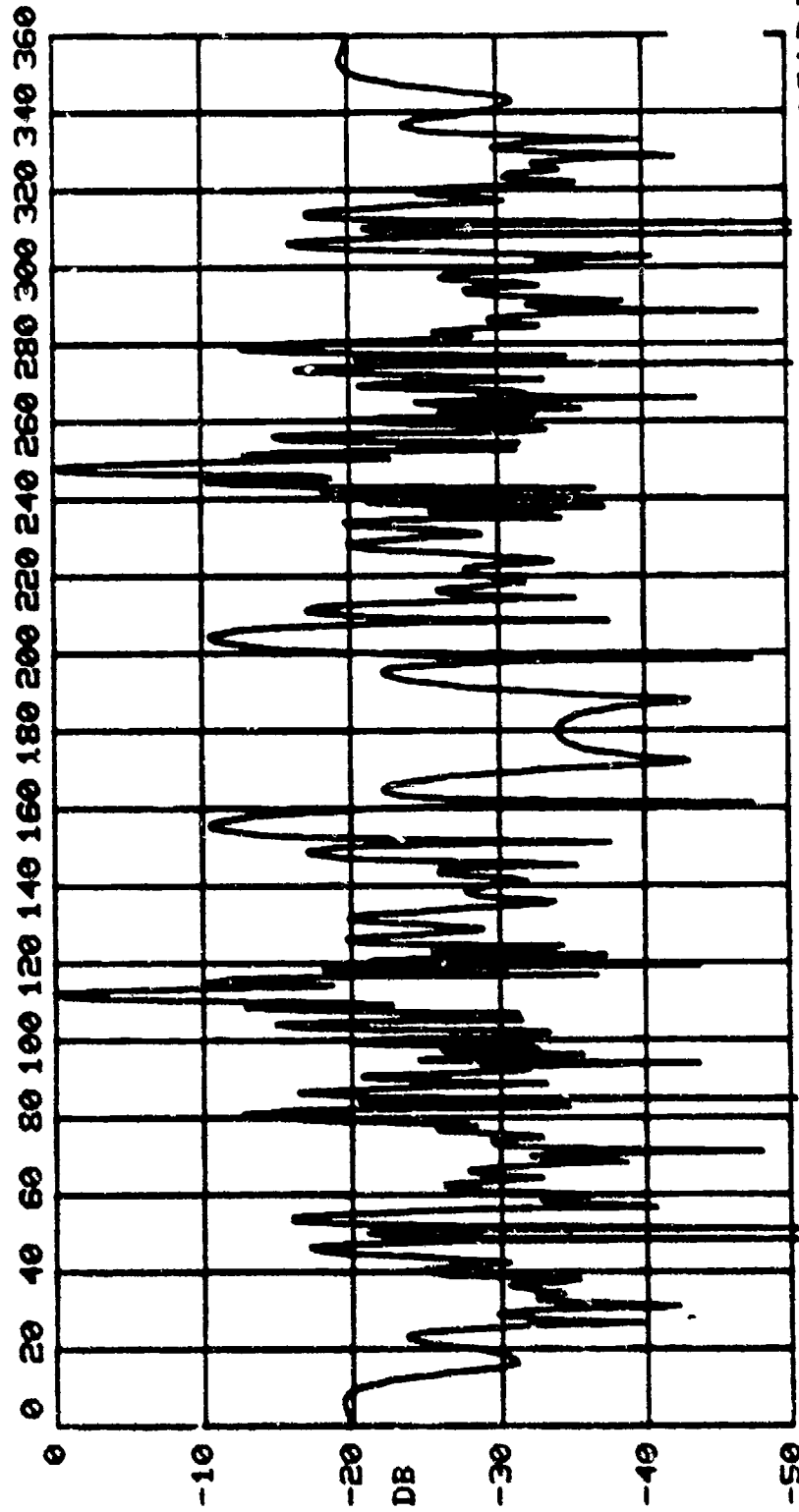
CONFIDENTIAL

Figure B-7/ Theoretical Horizontal Plane Pattern for 16 Element
Array @ 140 Hz for Data Point 7, 28 Off Broadside
Steering. Beamwidth 15.98°, Azimuth Gain 10.0 dB.

CONFIDENTIAL

3400E SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
..: 3400E ARRAY TUNED TO 300 HZ.
..: 3400E 3 FT. UNIFORM SPACING.
..: 3400E

DATA POINT 7
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 51 ELEMENTS, -0.89 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 112.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.06 DEG. 3 DB BEAM, 17.17 DB AZ. GAIN, MAX. AT 248.0 DEG. HORIZ.



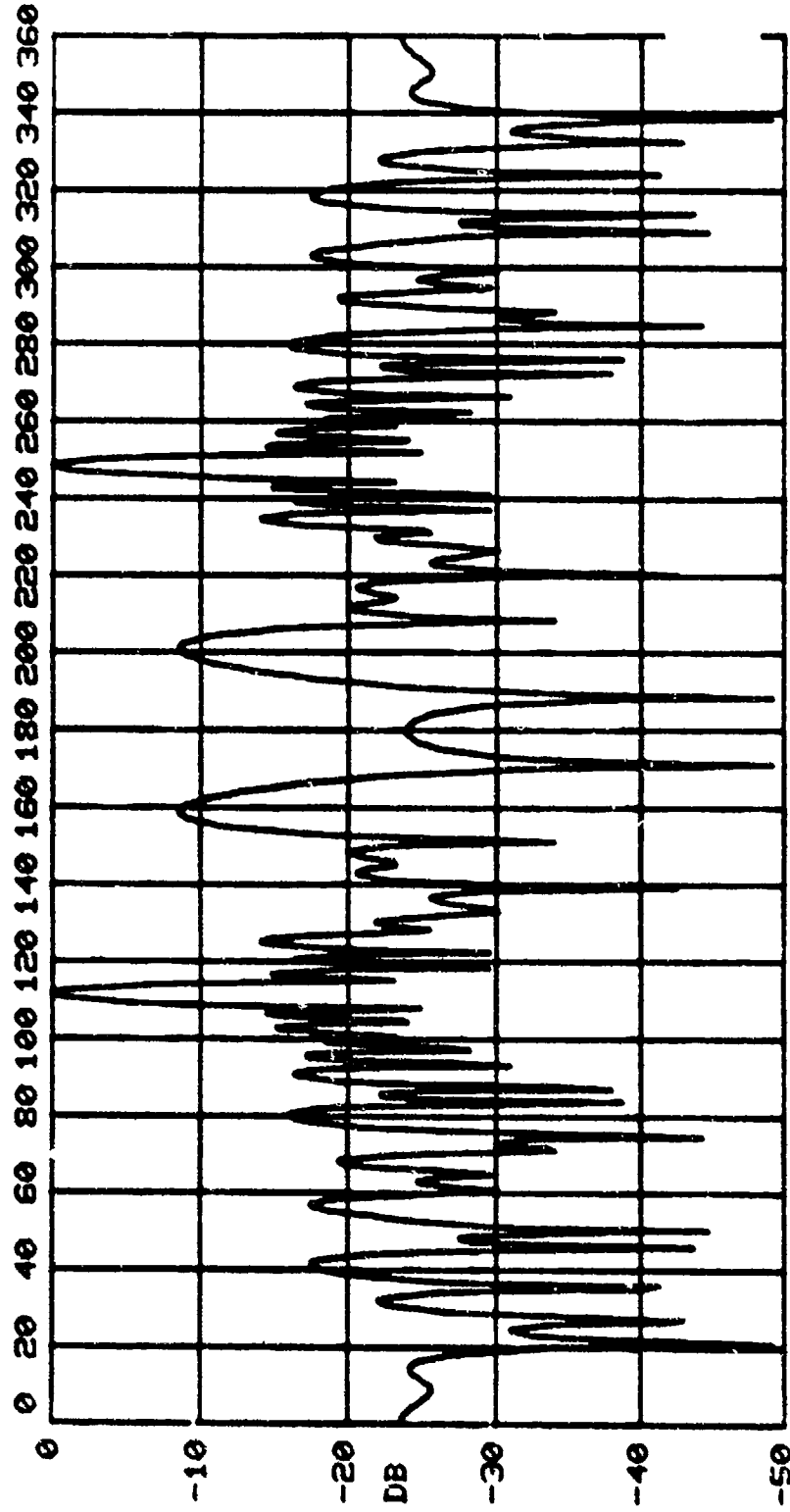
CONFIDENTIAL

Figure 3-7a Theoretical Horizontal Plane Pattern for 51 Element
Array @ 295 Hz for Data Point 7, 22 Off Broadside
Steering. Beamwidth 2.06°, Azimuth Gain 17.17 dB.

CONFIDENTIAL

3-20-73 SAIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLBP 3.1
-- 3-20-73 ARRAY TUNED TO 300 HZ.
-- 3-20-73 3 FT. UNIFORM SPACING.
-- 3-20-73

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 32 ELEMENTS, -0.78 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 111.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.27 DEG. 3 DB BEAM, 15.12 DB AZ. GAIN, MAX. AT 111.5 DEG. HORIZ.

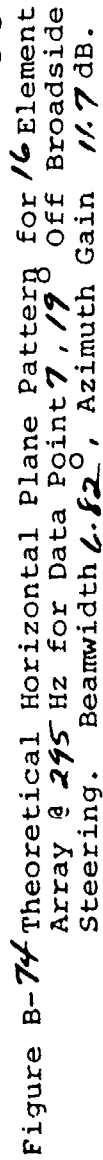


CONFIDENTIAL

Figure E-73 Theoretical Horizontal Plane Pattern for 32 Element
Array at 295 Hz for Data Point 7, 205 Off Broadside
Steering. Beamwidth 3.27°, Azimuth Gain 15.12 dB.

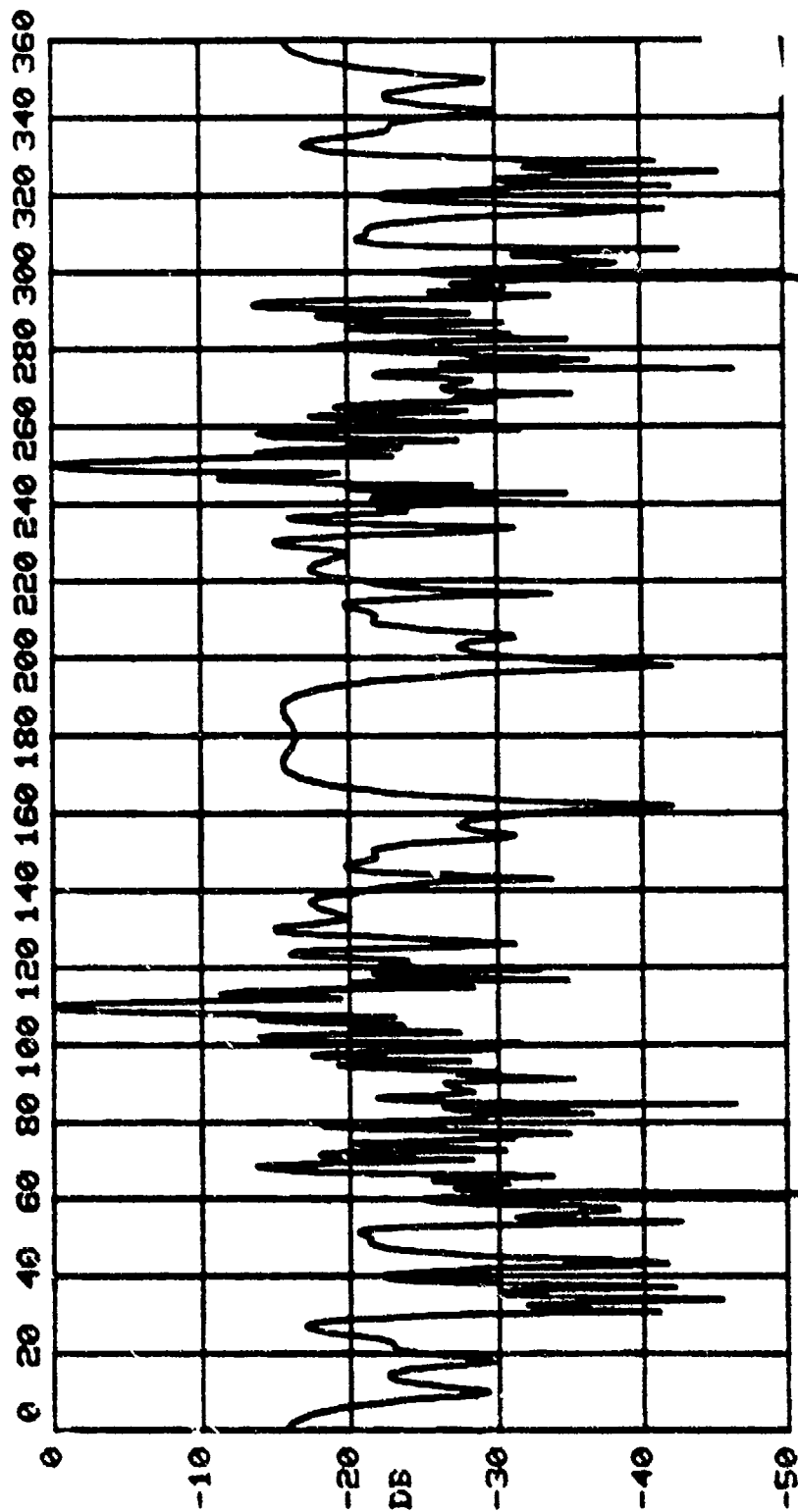
CONFIDENTIAL

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 16 ELEMENTS, -0.85 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 109.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.82 DEG. 3 DB BEAM, 11.73 DB AZ. GAIN, MAX. AT 109.0 DEG. HORIZ.



CONFIDENTIAL

DATA POINT 3
 1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 220.0 HZ., 48 ELEMENTS, -0.86 DB MAX., AC:54343, SU:54343, WT:
 90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 2.09 DEG. 3 DB BEAM, 16.92 DB AZ. GAIN, MAX. AT 110.0 DEG. HORIZ.



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Figure B-75 Theoretical Horizontal Plane Pattern for 48 Element
 Array at 290 Hz for Data Point 8, 20 Off Broadside
 Steering. Beamwidth 2.09°, Azimuth Gain 16.9 dB.

CONFIDENTIAL

5402A SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLBP 3.1
...: 1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
...: 32 ELEMENTS, -0.86 DB MAX., AC:54342, SU:54342, UT:
...: 90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
...: 3.30 DEG. 3 DB BEAM, 15.22 DB AZ. GAIN, MAX. AT 110.0 DEG. HORIZ.

DATA POINT 8

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

230.0 HZ., 32 ELEMENTS, -0.86 DB MAX., AC:54342, SU:54342, UT:

90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

3.30 DEG. 3 DB BEAM, 15.22 DB AZ. GAIN, MAX. AT 110.0 DEG. HORIZ.

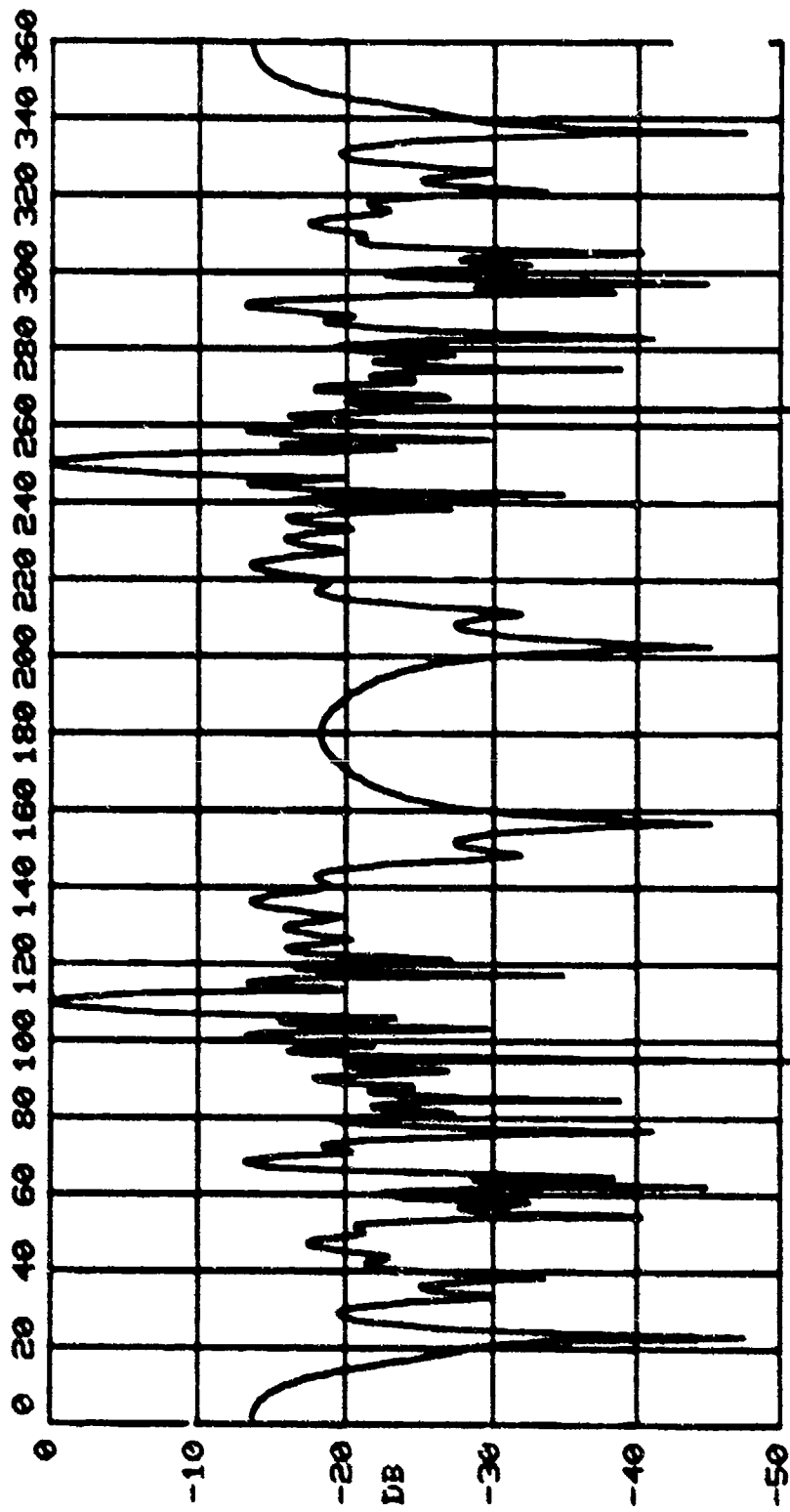


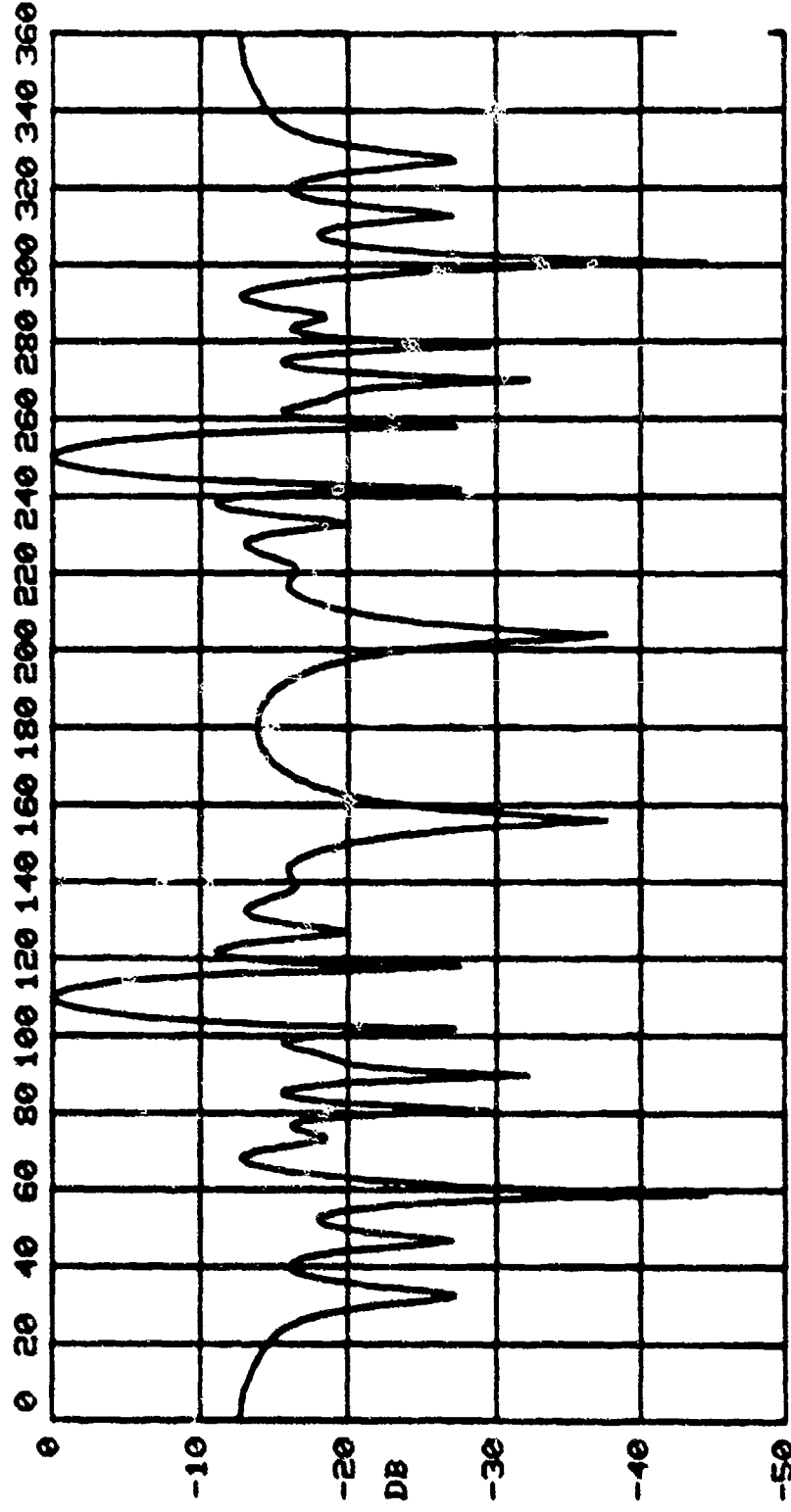
Figure E-76 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 240 Hz for Data Point 8, 20° Off Broadside
Steering. Beamwidth 3.30°, Azimuth Gain 15.2 dB.

CONFIDENTIAL

CONFIDENTIAL

54014 SAUNDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLP 3.1
16 ELEMENT ARRAY TUNED TO 300 HZ.
2.0223 FT. UNIFORM SPACING
1: 5012

DATA POINT 8
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 16 ELEMENTS, -0.85 DB MAX., AC:54341, SU:54341, WT:
90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.06 DEG. 3 DB BEAM, 12.12 DB AZ. GAIN, MAX. AT 110.0 DEG. HORIZ.



CONFIDENTIAL

Figure 2-77 Theoretical Horizontal Plane Pattern for 16 Element Array @ 290 Hz for Data Point 8, 20 Off Broadside Steering. Beamwidth 7.06°, Azimuth Gain 2.1 dB.

CONFIDENTIAL

SHANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLP 3.1
ARRAY APPAR TUNED TO 300 HZ.
3.2223 FT. UNIFORM SPACING
DATE

DATA POINT 8
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 48 ELEMENTS, -0.18 DB MAX., AC:54343, SU:54343, WT:
90.0 DEG. VERT. RESP., 102.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.16 DEG. 3 DB BEAM, 15.30 DB AZ. GAIN, MAX. AT 102.0 DEG. HORIZ.

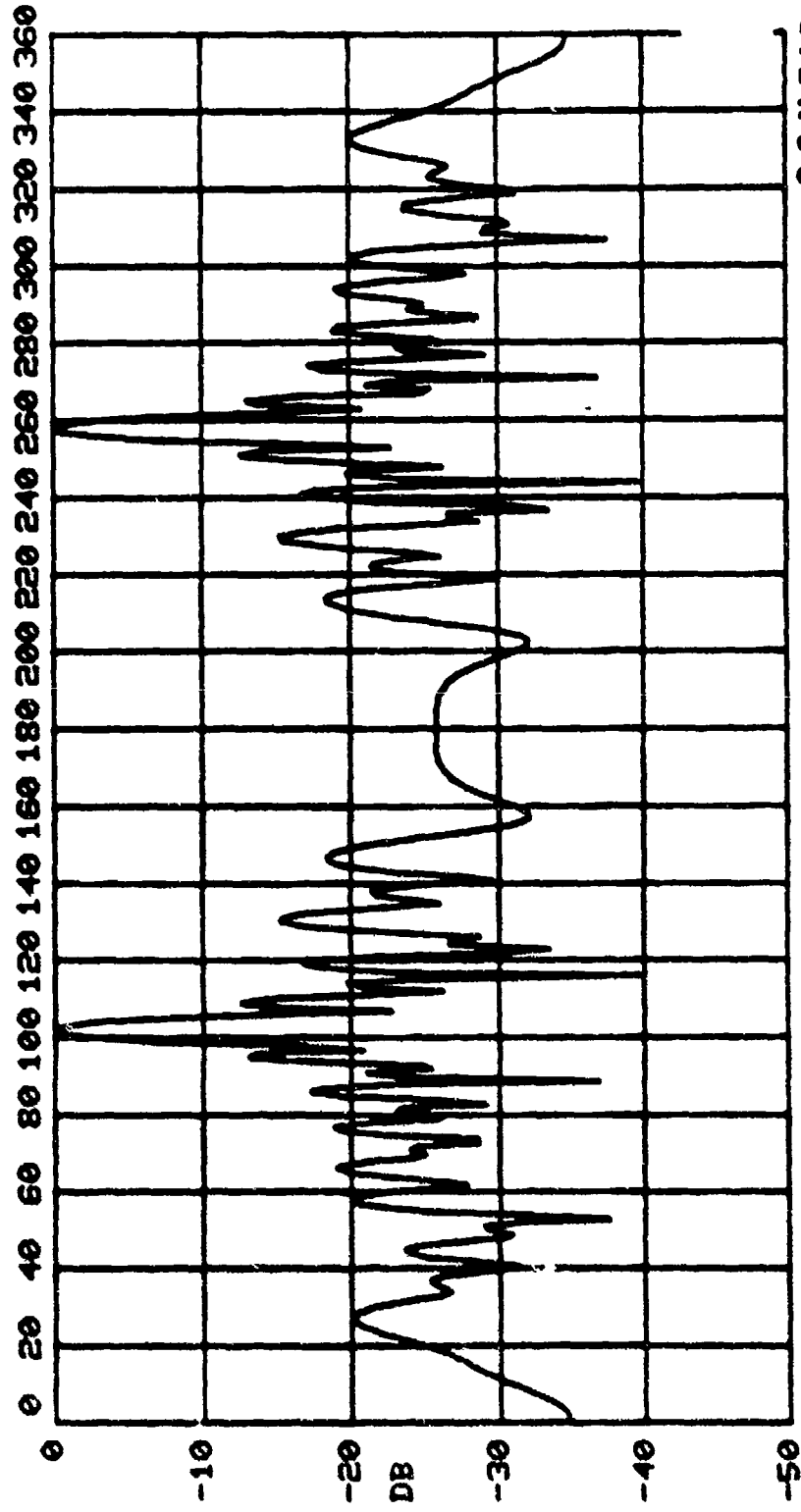


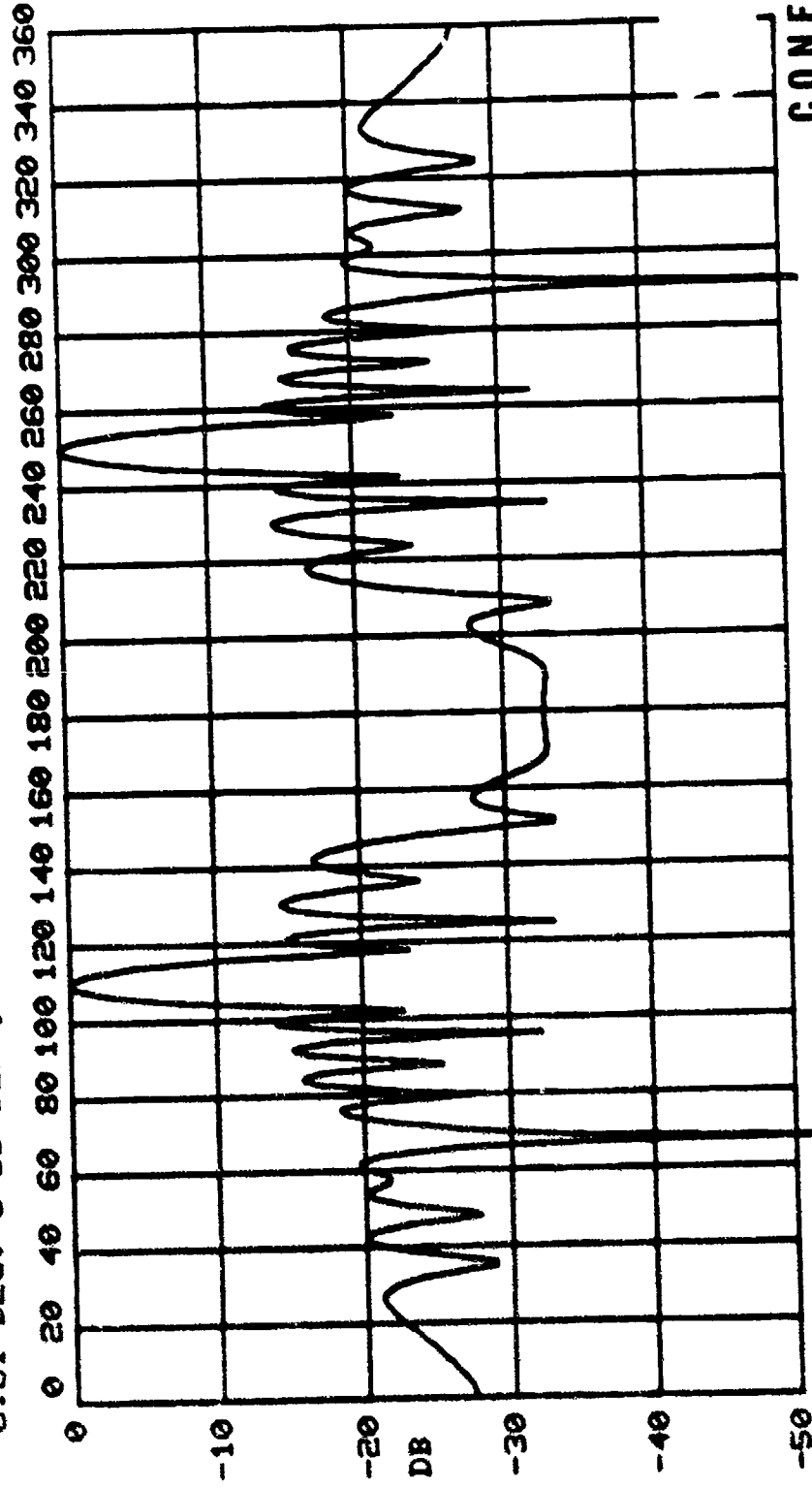
Figure B-78 Theoretical Horizontal Plane Pattern for 48 Element Array @ 140 Hz for Data Point 8, 1/2 Off Broadside Steering. Beamwidth 4.16°, Azimuth Gain 15.3 dB.

CONFIDENTIAL

CONFIDENTIAL

5402J SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
 32 ELEMENT ARRAY TUNED TO 300 HZ.
 1.000 FT. UNIFORM SPACING
 540E

DATA POINT 8
 1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 140.0 HZ., 32 ELEMENTS, -0.18 DB MAX., AC:54342, SU:54342, WT:
 90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 6.81 DEG. 3 DB BEAM, 13.36 DB AZ. GAIN, MAX. AT 110.0 DEG. HORIZ.



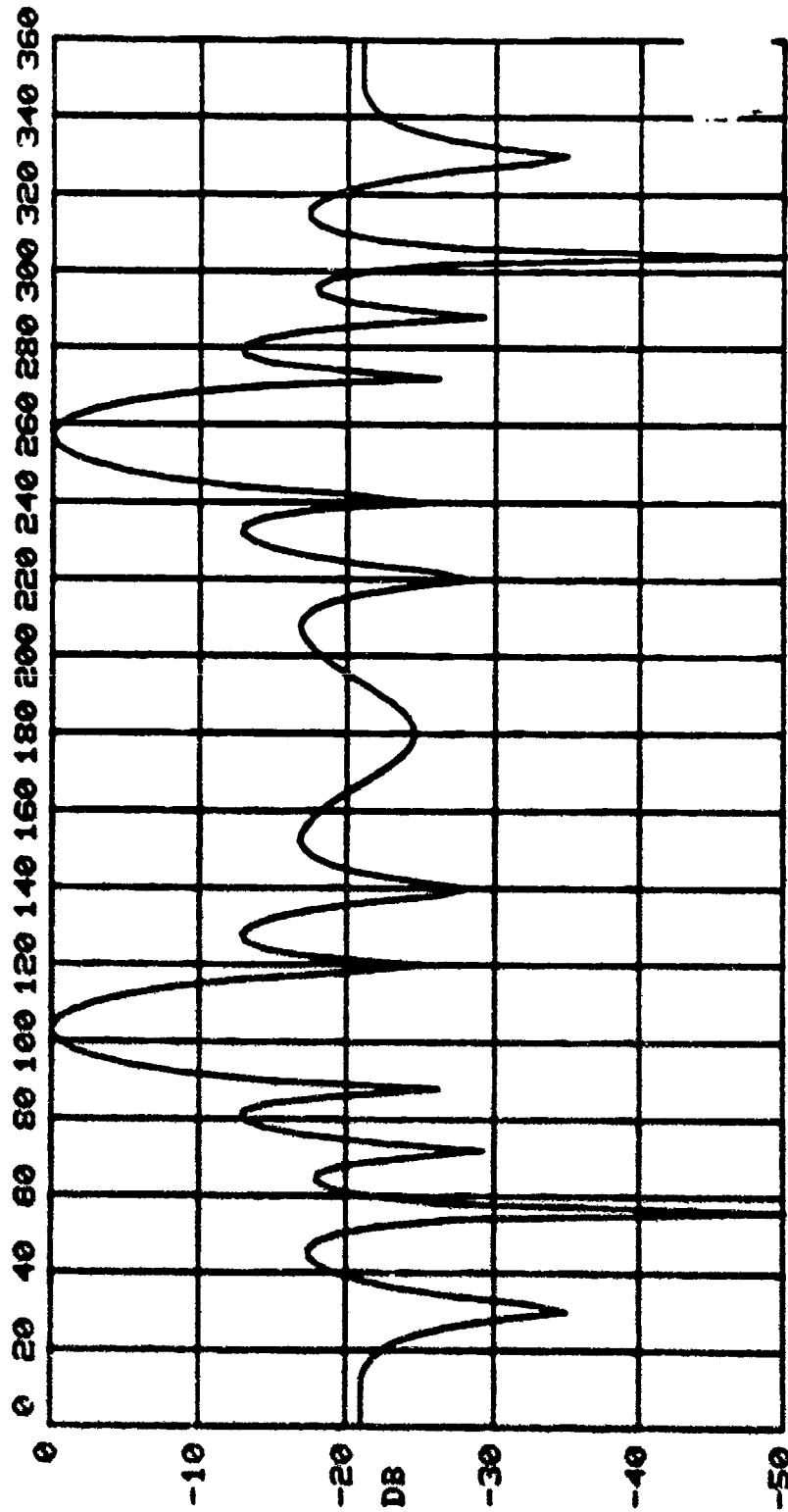
CONFIDENTIAL

Figure B-79 Theoretical Horizontal Plane Pattern for 32 Element
 Array @ 140 Hz for Data Point 8, 20 Off Broadside
 Steering. Beamwidth 6.81°, Azimuth Gain 13.3 dB.

CONFIDENTIAL

S4020 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLP 3.1
4: 00000 HZ. ARRAY TUNED TO 300 HZ.
5: 00000 FT. UNIFORM SPACING
6: 00000

DATA POINT 8
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 15 ELEMENTS, -0.22 DB MAX., AC: S4341, SU: S4341, WT:
90.0 DEG. VERT. RESP., 103.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
14.07 DEG. 3 DB BEAM, 10.40 DB AZ. GAIN, MAX. AT 102.0 DEG. HORIZ.



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Figure B-80 Theoretical Horizontal Plane Pattern for 16 Element Array @ 140 Hz for Data Point 8, 13 Off Broadside Steering. Beamwidth 14.07°, Azimuth Gain 10.4 dB.

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54000 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 QNTLEP 3.1
 1000 HZ. ARRAY TUNED TO 300 HZ.
 1000 FT. UNIFORM SPACING
 1: 54000

DATA POINT 8
 1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 295.0 HZ. 48 ELEMENTS, -0.85 DB MAX., AC:54343, SU:54343, UT:
 90.0 DEG. VERT. RESP., 102.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 1.96 DEG. 3 DB BEAM, 17.04 DB AZ. GAIN, MAX. AT 102.0 DEG. HORIZ.

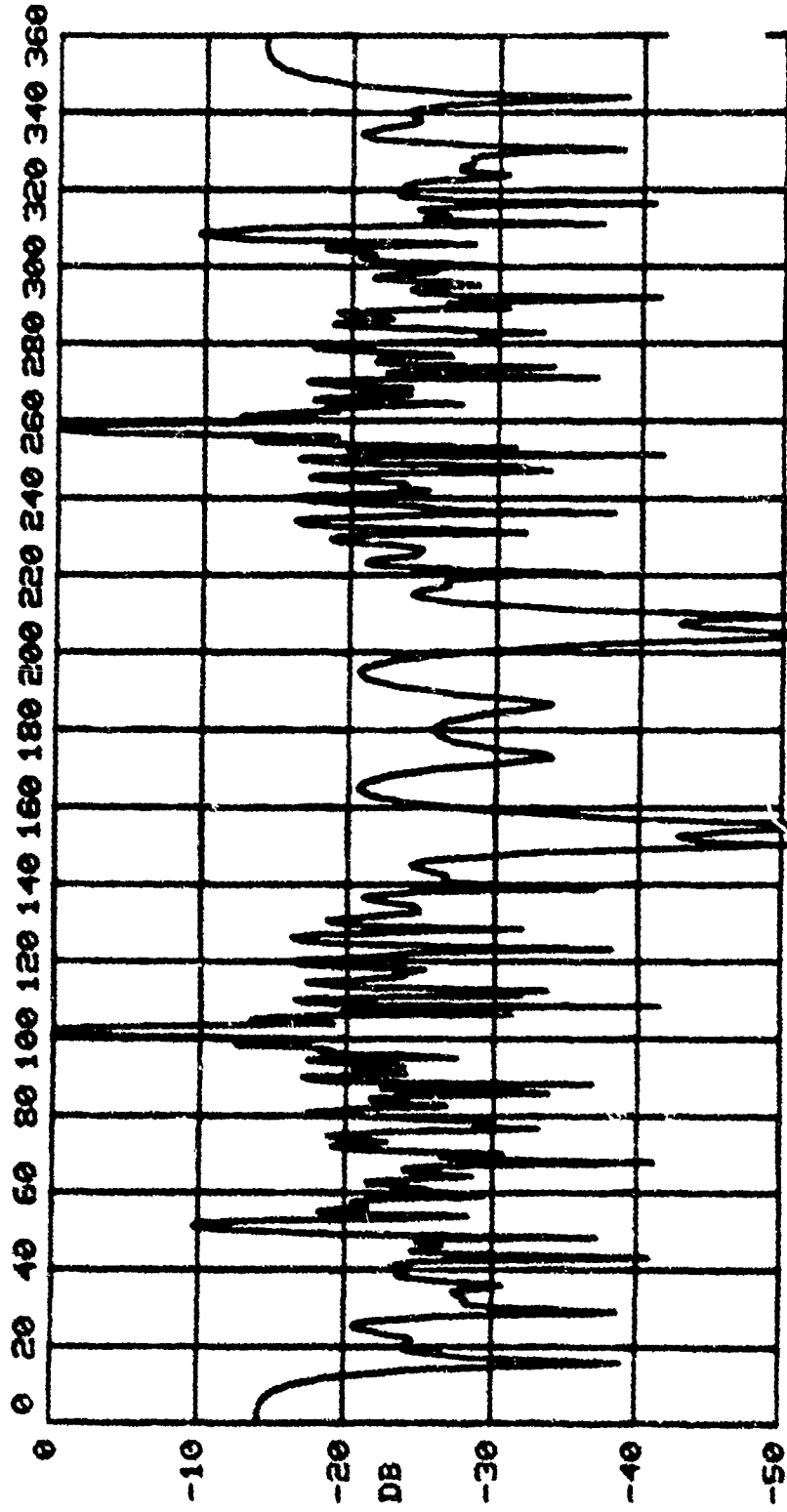


Figure B-8/ Theoretical Horizontal Plane Pattern for 48 Element
 Array 295 Hz for Data Point 8, 1/2 Off Broadside
 Steering. Beamwidth 1.96°, Azimuth Gain 17.0 dB.

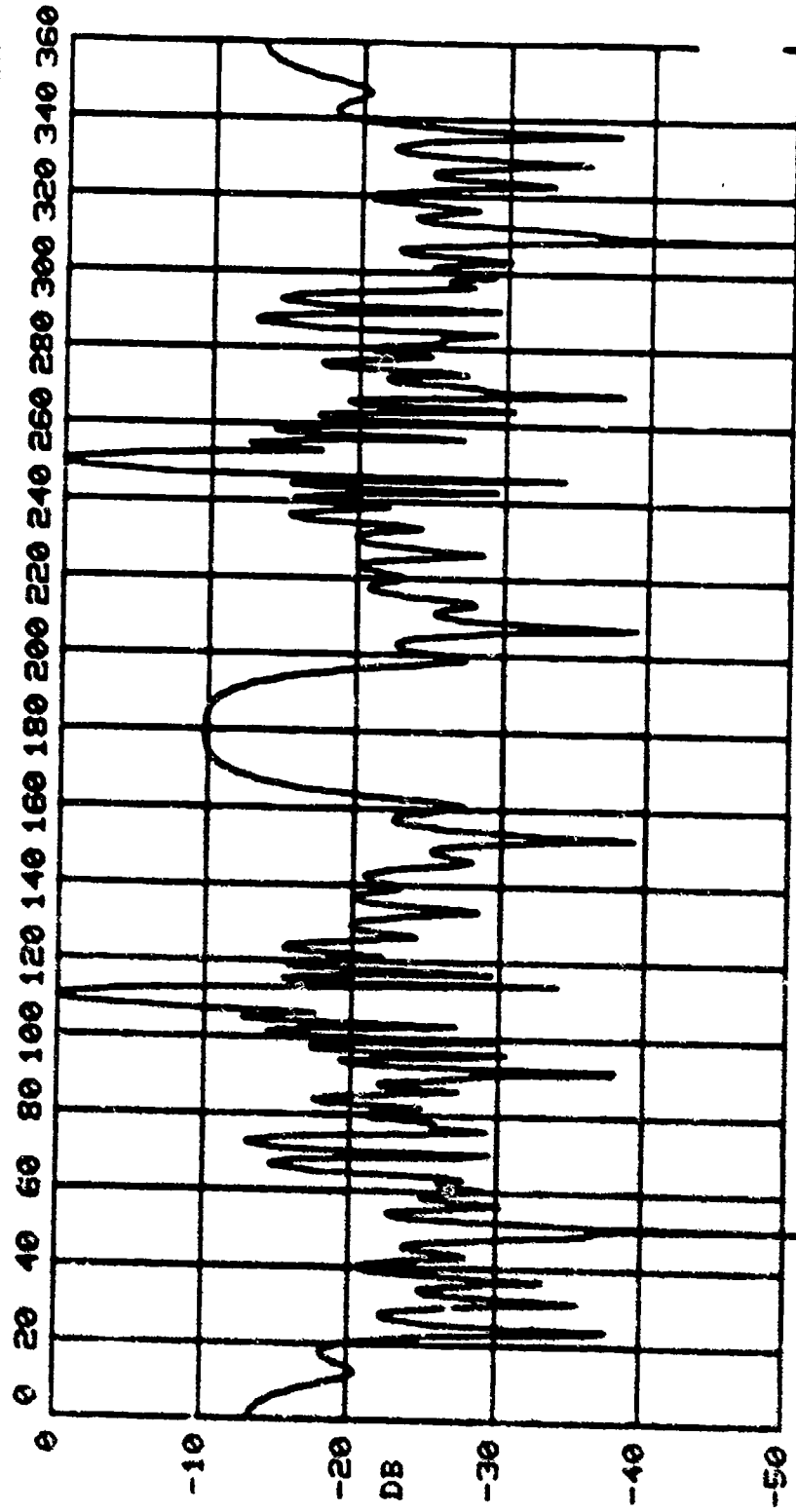
CONFIDENTIAL

CONFIDENTIAL

S402L SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
... 3000 Hz. ARRAY TUNED TO 300 HZ.
... 3.1223 FT. UNIFORM SPACING
... 5016

DATA POINT 8

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 32 ELEMENTS, -0.84 DB MAX., AC:54342, SU:54342, UT:
90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.24 DEG. 3 DB BEAM, 14.68 DB AZ. GAIN, MAX. AT 250.0 DEG. HORIZ.



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Figure B-f2 Theoretical Horizontal Plane Pattern for 32 Element
Array at 295 Hz for Data Point 8, 20 Off Broadside
Steering. Beamwidth 3.24°, Azimuth Gain 14.68 dB.

CONFIDENTIAL

34021 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
... 30000 HZ. TUNED TO 300 HZ.
... 1.000 FT. UNIFORM SPACING
... 5000

DATA POINT 8
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
205.0 HZ., 16 ELEMENTS, -0.87 DB MAX., AC:54341, SU:54341, UT:
90.0 DEG. VERT. RESP., 101.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.62 DEG. 3 DB BEAM, 12.28 DB AZ. GAIN, MAX. AT 101.0 DEG. HORIZ.

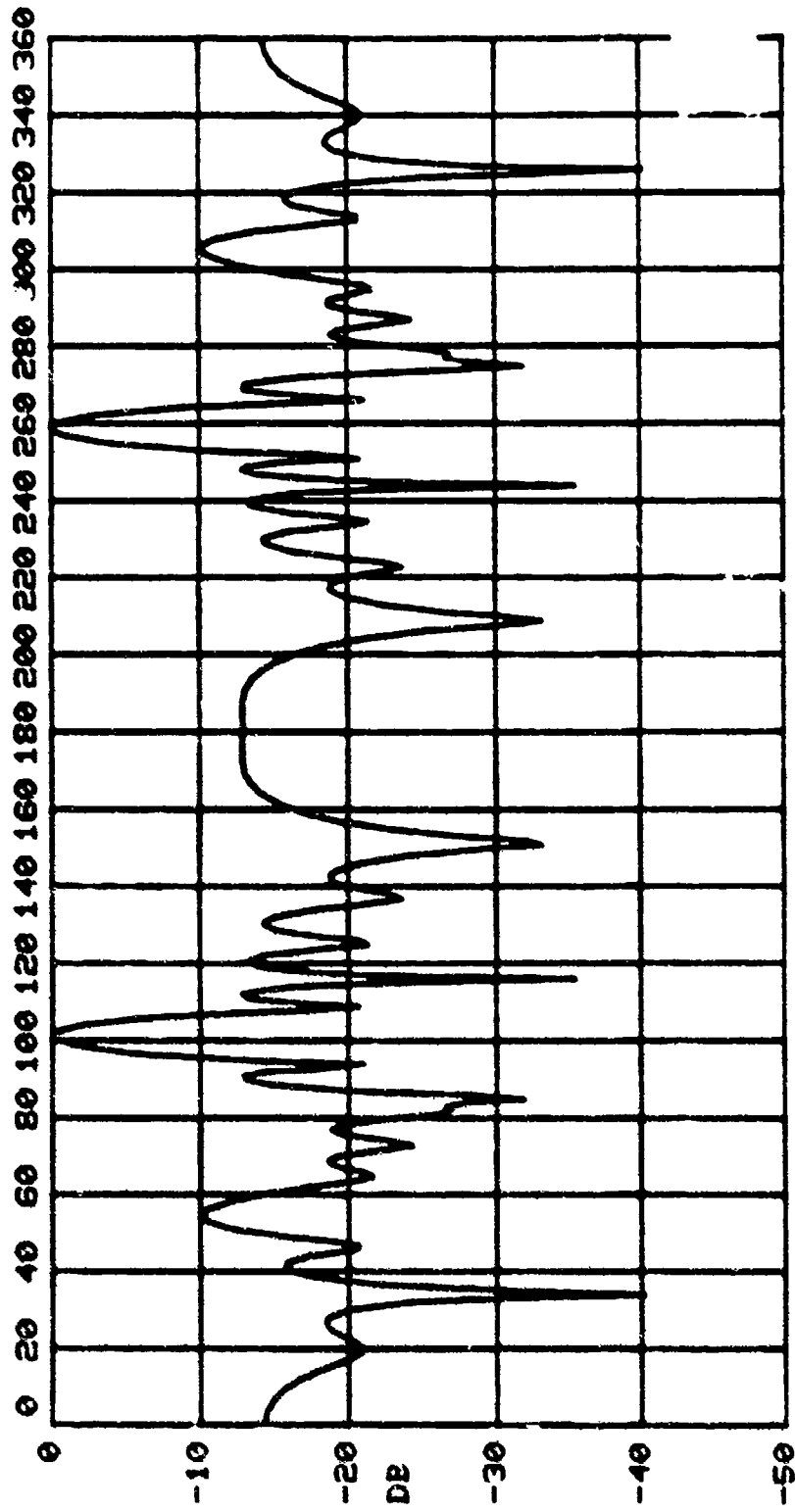


Figure B-83 Theoretical Horizontal Plane Pattern for 16 Element Array @ 295 Hz for Data Point 8, // Off Broadside Steering. Beamwidth 6.62°, Azimuth Gain 12.2 dB.

CONFIDENTIAL

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5105B 5-NDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEP 3.1

1. 5105B 5-NDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEP 3.1

2. 5105B 5-NDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEP 3.1

3. 5105B 5-NDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEP 3.1

4. 5105B 5-NDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEP 3.1

UNIFORM WEIGHTING.

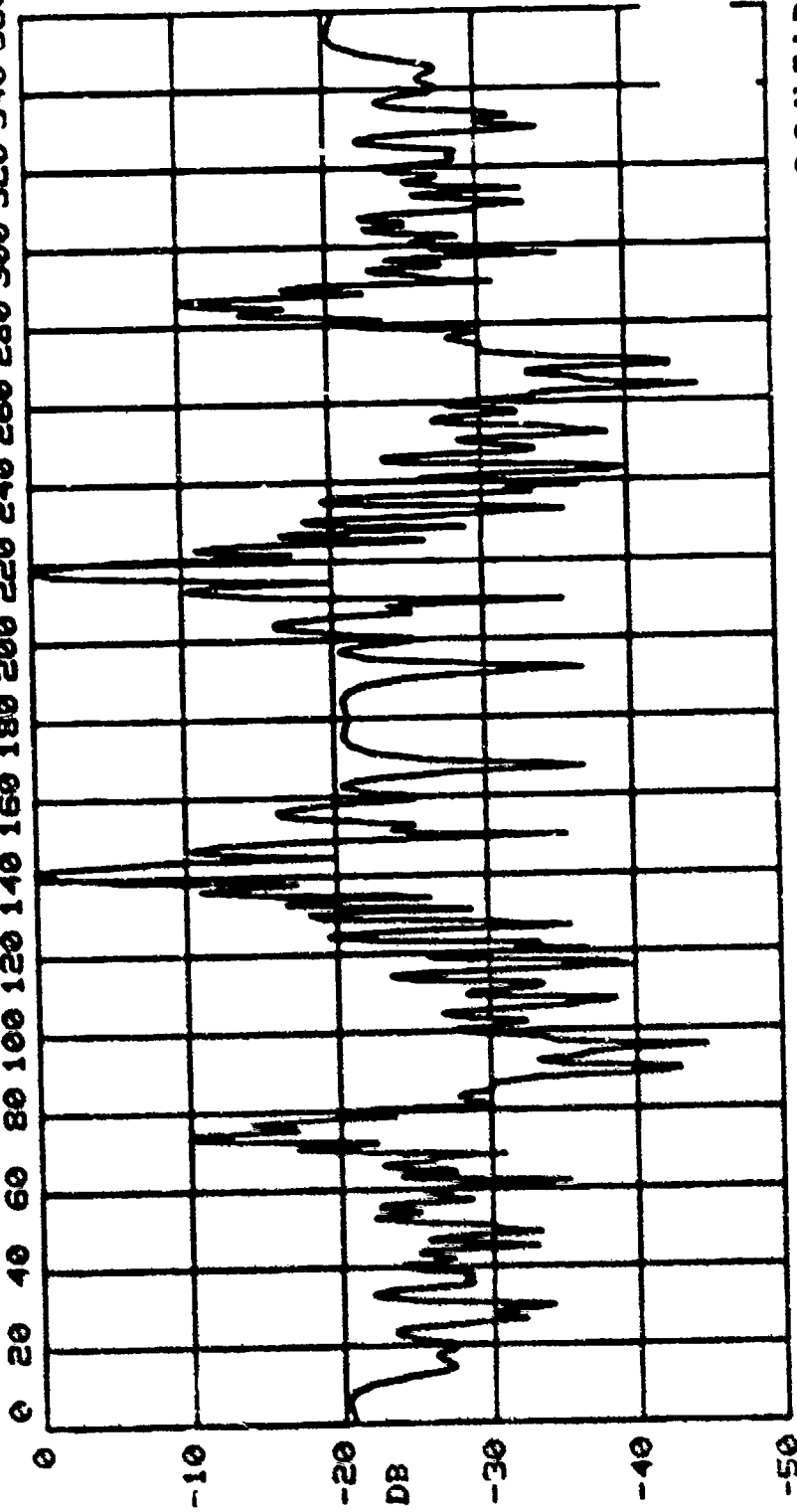
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

300.0 HZ. 51 ELEMENTS, -0.80 DB MAX., AC:51361, SU:51361, WT:

90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

3.11 DEG. 3 DB BEAM, 16.04 DB AZ. GAIN, MAX. AT 141.5 DEG. HORIZ.

0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360



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Figure B-54 Theoretical Horizontal Plane Pattern for 51 Element Array 3.270 Hz for Data Point 9, 5/ Off Broadside Steering. Beamwidth 3.11°, Azimuth Gain 16.0 dB.

CONFIDENTIAL

51052 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 CNTLRF 3.1
: 1.000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
: 1.000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
: 1.000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
: 1.000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

UNIFORM WEIGHTING.
1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 32 ELEMENTS, -0.61 DB MAX., AC:S1361, SU:S1361, UT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.95 DEG. 3 DB BEAM, 14.21 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.

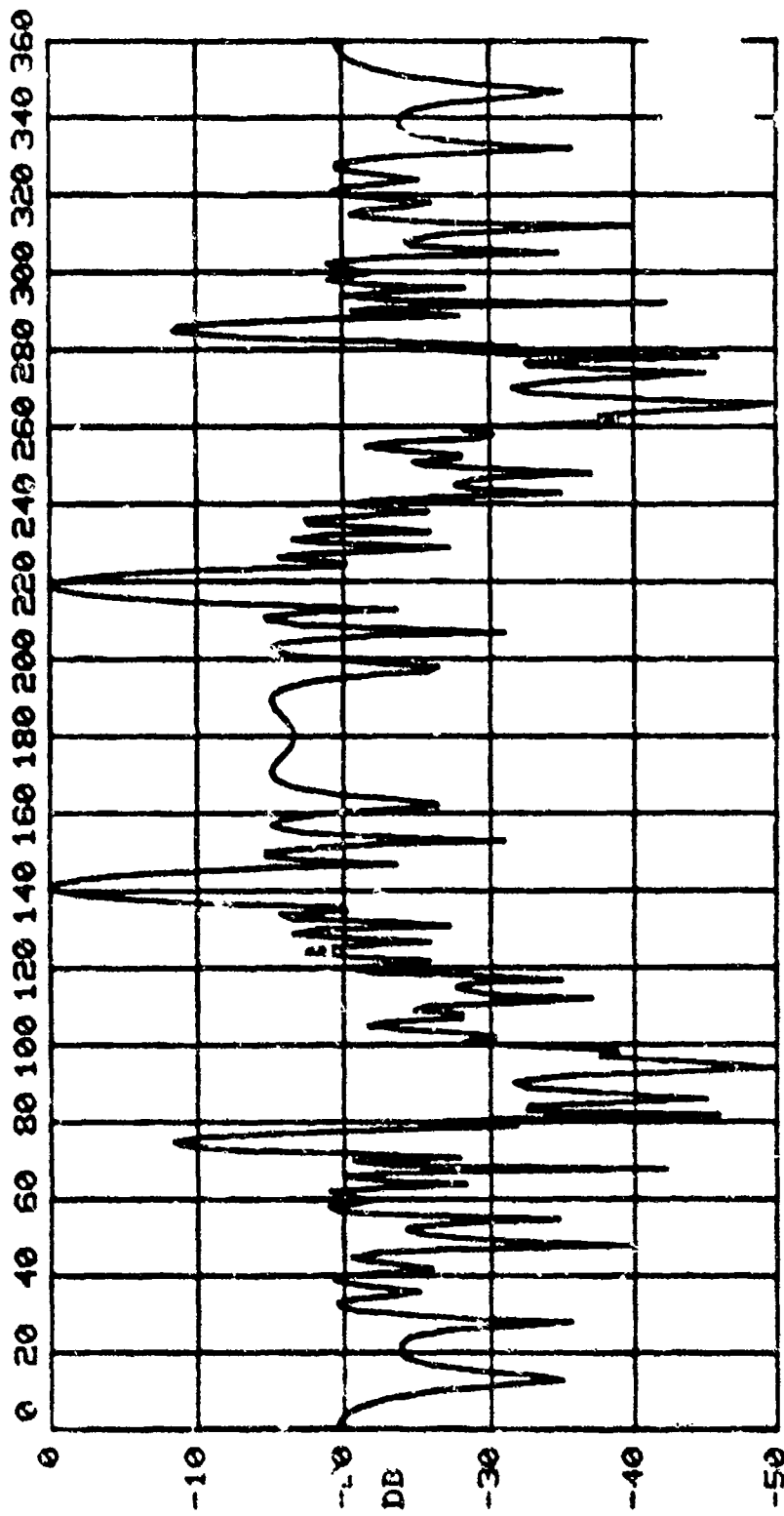


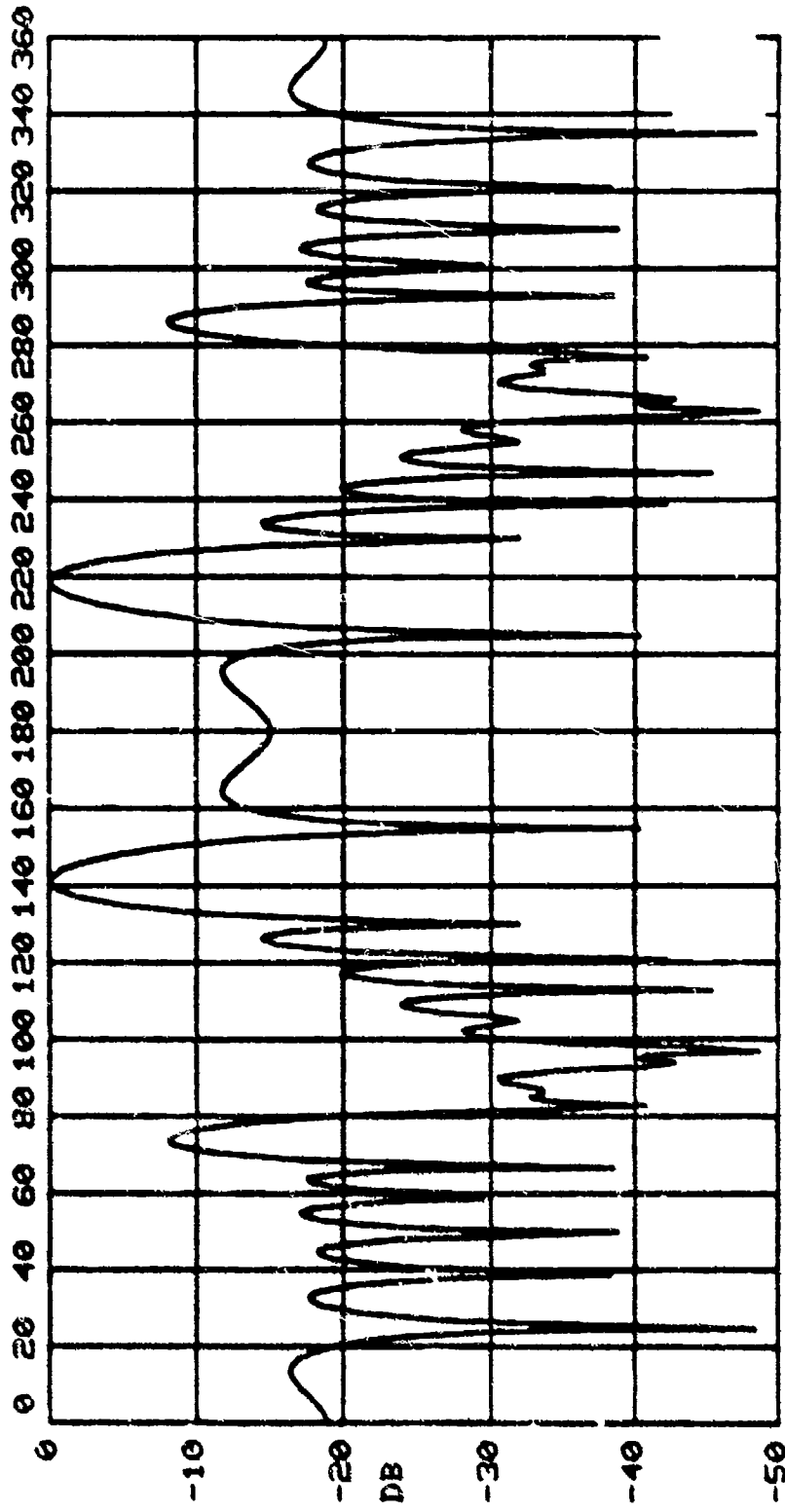
Figure B-85 Theoretical Horizontal Plane Pattern for 32 Element
Array & 290 Hz for Data Point 9, 575 Off Broadside
Steering. Beamwidth 4.95°, Azimuth Gain 14.2 dB.

CONFIDENTIAL

CONFIDENTIAL

01055 540ERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 04TUBF 3.1
 : 1000 HZ. TUNED TO 300 HZ.
 : 1000 HZ. UNIFORM SPACING
 : 1000 HZ.

UNIFORM WEIGHTING.
 1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 290.0 HZ., 16 ELEMENTS, -0.60 DB MAX., AC:S1361, SU:S1361, UT:
 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 10.56 DEG. 3 DB BEAM, 11.10 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.



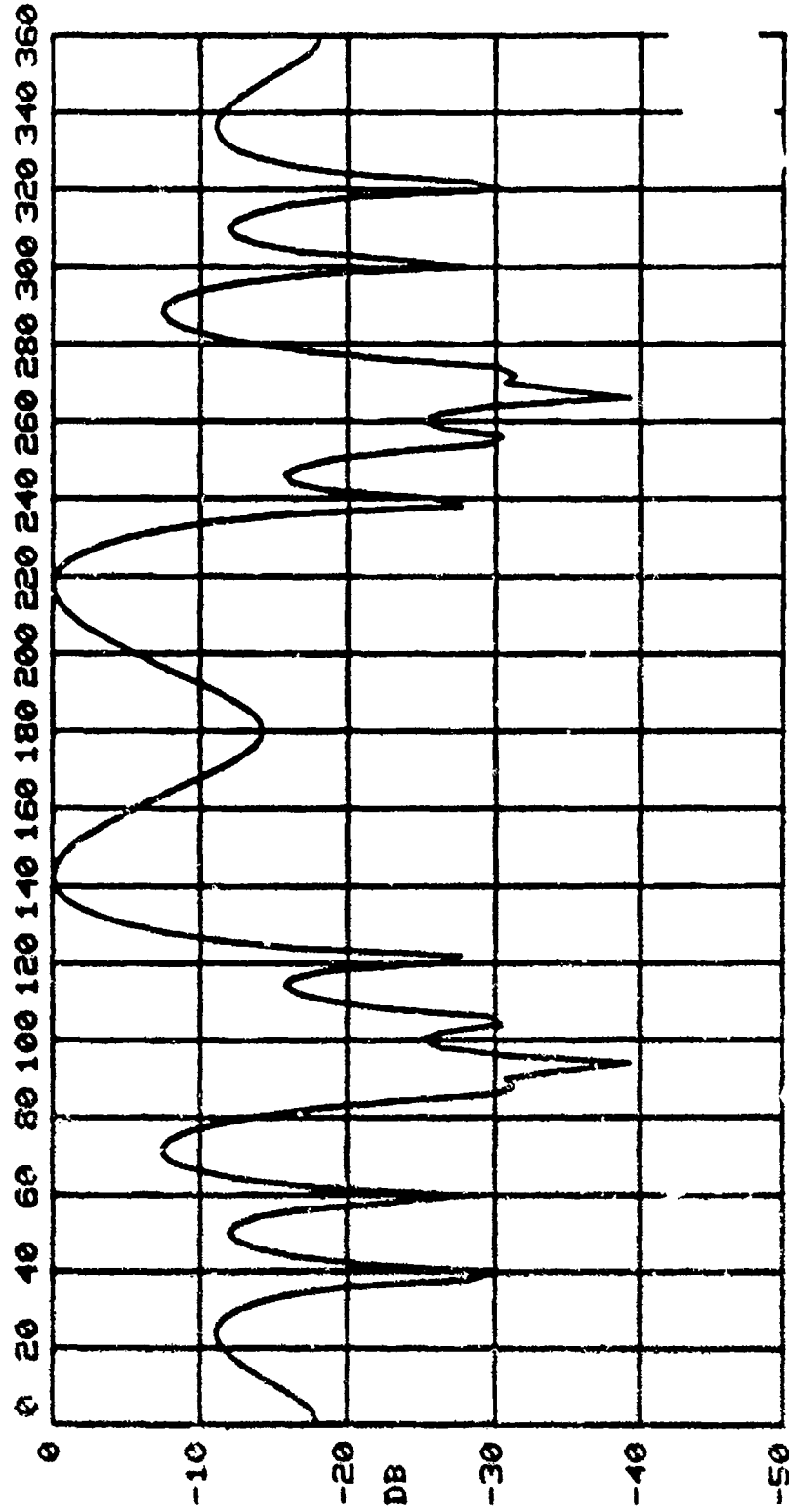
CONFIDENTIAL

Figure B-86 Theoretical Horizontal Plane Pattern for 16 Element
 Array @ 290 Hz for Data Point 9, 575 Off Broadside
 Steering. Beamwidth 10.56°, Azimuth Gain 11.1 dB.

CONFIDENTIAL

SL152 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-78 ONTLEP 2.1
 ... 3000 HZ. ARRAY TUNED TO 300 HZ.
 ... 3.0033 FT. UNIFORM SPACING

UNIFORM WEIGHTING.
 1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 220.0 HZ., 8 ELEMENTS, -0.56 DB MAX., AC:S1361, SU:S1361, WT:
 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 22.39 DEG. 3 DB BEAM, 7.96 DB AZ. GAIN, MAX. AT 142.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-87 Theoretical Horizontal Plane Pattern for 8 Element
 Array @ 290 Hz for Data Point 9, 575 Off Broadside
 Steering. Beamwidth 22.39°, Azimuth Gain 7.9 dB.

CONFIDENTIAL

S105A SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 QNTLBP 3.1

..: 1000 HZ. ARRAY TUNED TO 300 HZ.

: 1000 HZ. UNIFORM SPACING

: 1000

0.000

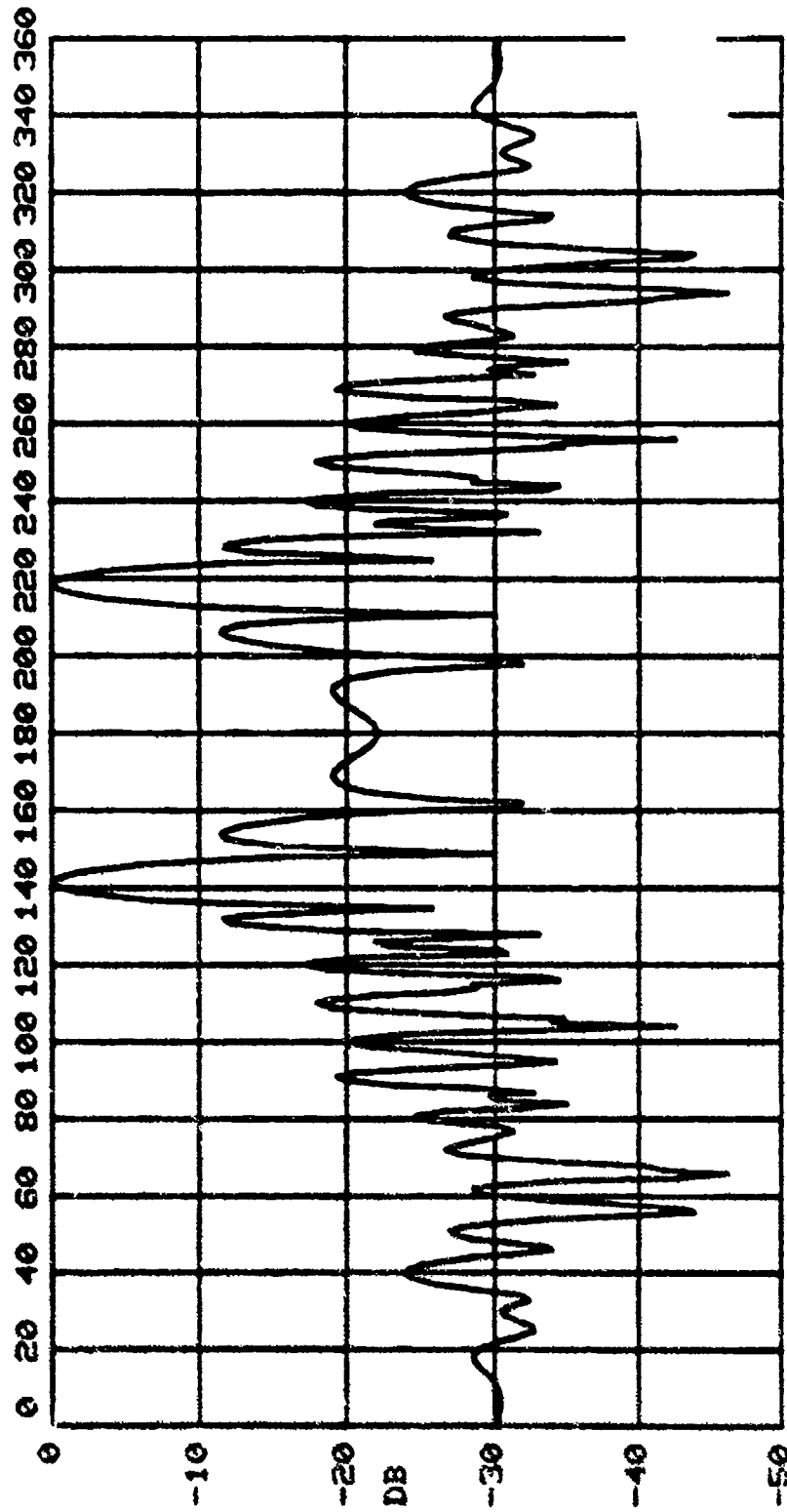
UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

140.0 HZ., 51 ELEMENTS, -0.22 DB MAX., AC:S1361, SU:S1361, UT:

90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

6.50 DEG. 3 DB BEAM, 13.64 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.



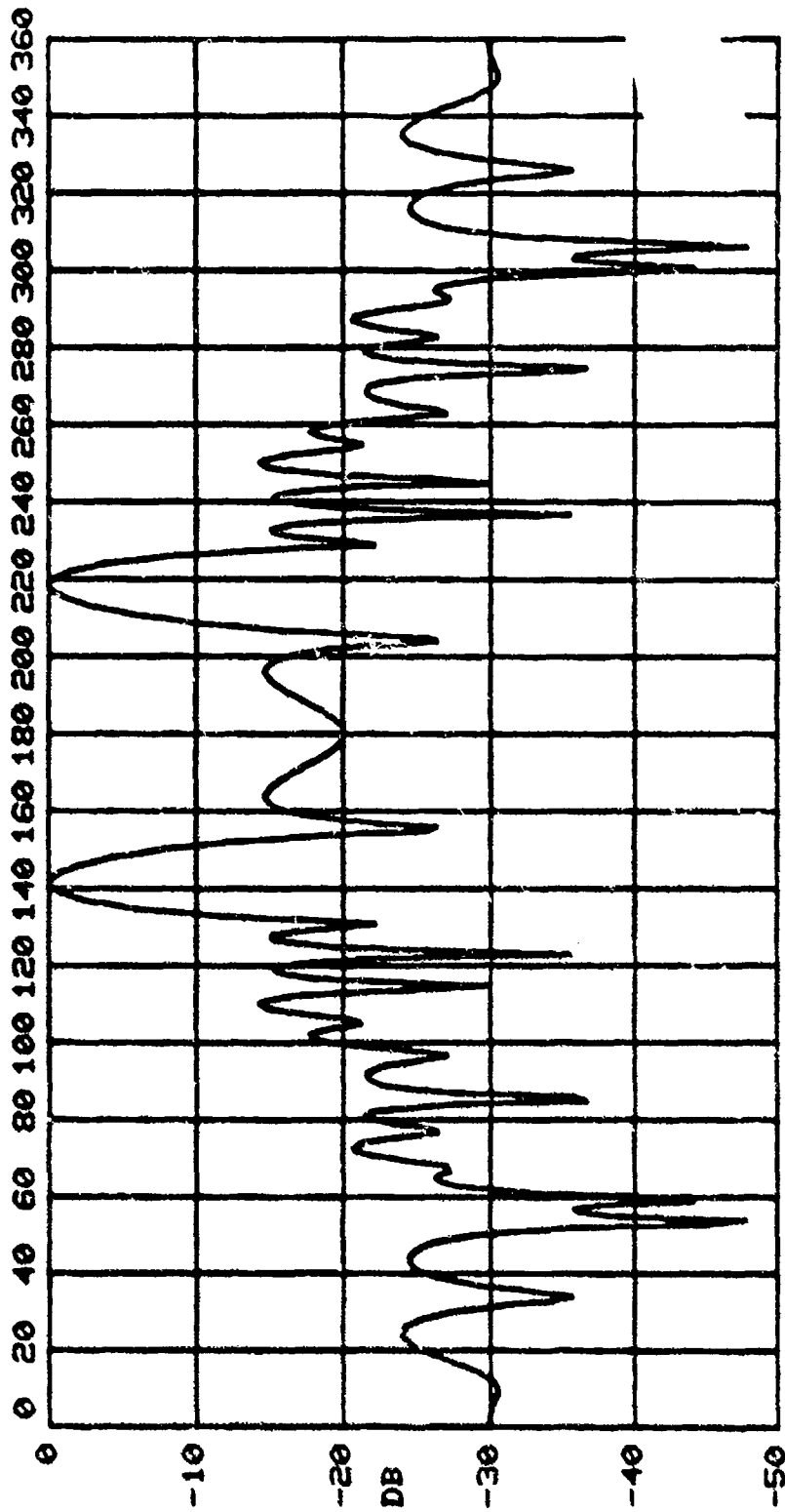
CONFIDENTIAL

Figure B-88 Theoretical Horizontal Plane Pattern for 51 Element Array @ 140 Hz for Data Point 9, 5/50 Off Broadside Steering. Beamwidth 6.50°, Azimuth Gain 13.64 dB.

CONFIDENTIAL

S1057 SAMPERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 UNTLRP 2.1
 : 1.000 HZ. ARRAY TURNED TO 300 HZ.
 : 1.000 HZ. UNIFORM SPACING
 : 1.000 HZ.

UNIFORM WEIGHTING.
 1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 140.0 HZ., 32 ELEMENTS, -0.19 DB MAX., AC: S1361, SU: S1361, UT:
 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 10.43 DEG. 3 DB BEAM, 11.74 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-89 Theoretical Horizontal Plane Pattern for 32 Element
 Array @ 140 Hz for Data Point 9, 575 Off Broadside
 Steering. Beamwidth 10.43°, Azimuth Gain 11.7 dB.

CONFIDENTIAL

51054 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 UNTLBP 3.1
 : 1000 HZ. 16 ELEMENTS, -0.16 DB MAX., AC:51361, SU:51361, WT:
 : 140.0 HZ., 16 ELEMENTS, 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 : 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 : 22.76 DEG. 3 DB BEAM, 8.48 DB AZ. GAIN, MAX. AT 142.0 DEG. HORIZ.

UNIFORM WEIGHTING.
 1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 140.0 HZ., 16 ELEMENTS, -0.16 DB MAX., AC:51361, SU:51361, WT:
 140.0 HZ., 16 ELEMENTS, 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 22.76 DEG. 3 DB BEAM, 8.48 DB AZ. GAIN, MAX. AT 142.0 DEG. HORIZ.

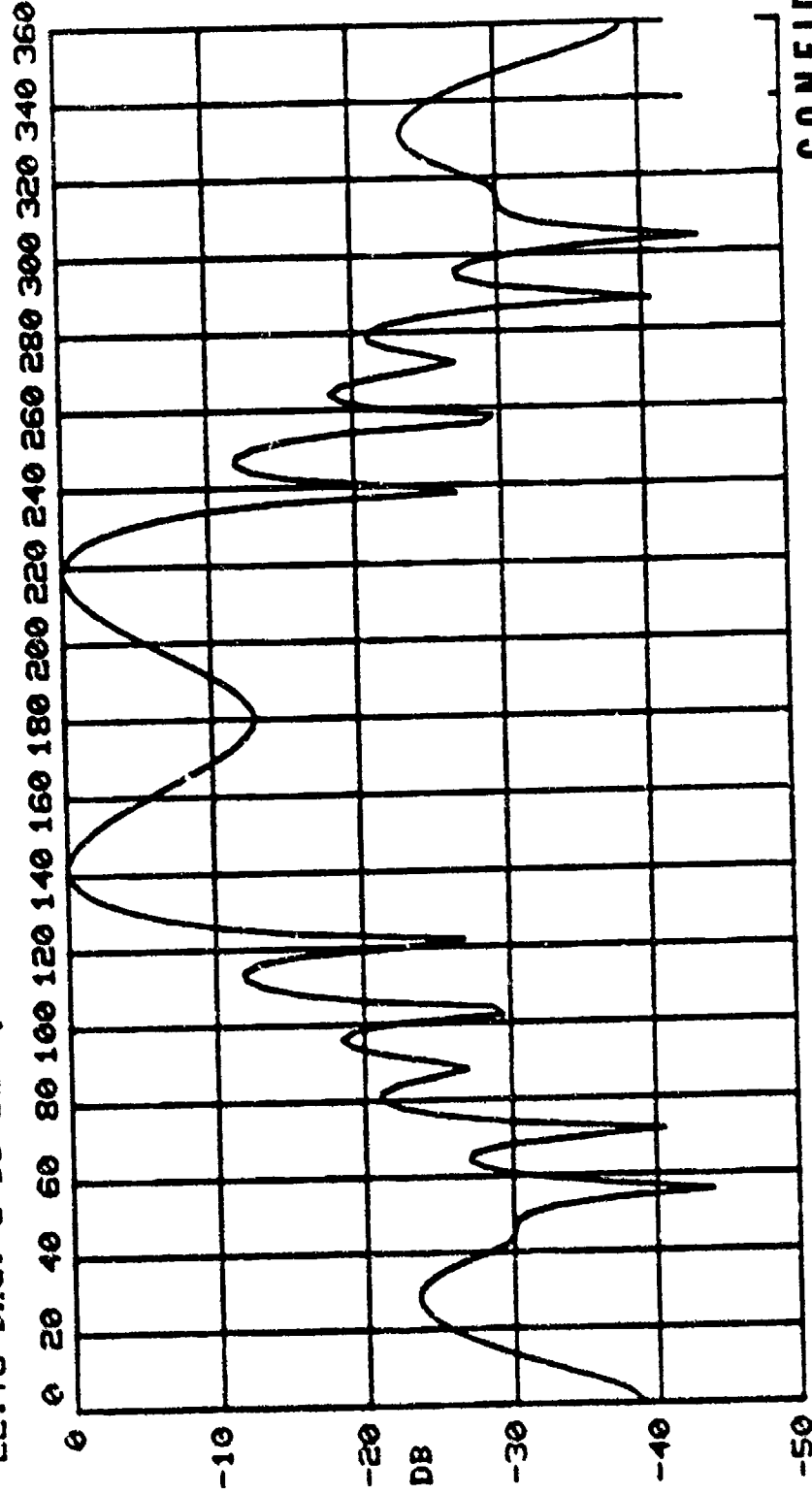


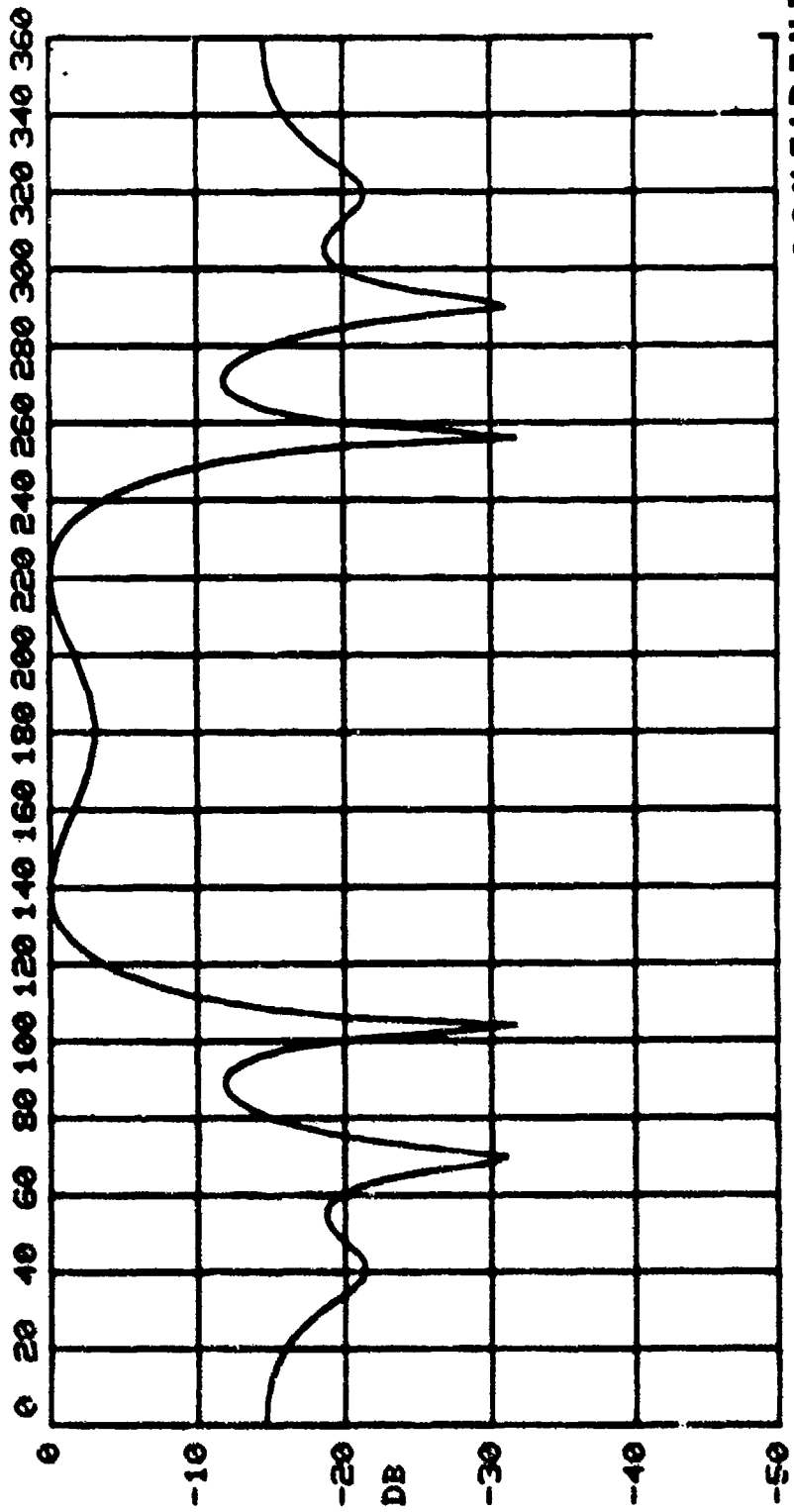
Figure B-90 Theoretical Horizontal Plane Pattern for 16 Element Array @ 140 Hz for Data Point 8, 57.5 Off Broadside Steering. Beamwidth 22.76°, Azimuth Gain 8.4 dB.

CONFIDENTIAL

CONFIDENTIAL

51001 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Jan-78 ONTLEP 3.1
 1.000 HZ. TUNED TO 300 HZ.
 1.0000 FT. UNIFORM SPACING
 : 1.0000

UNIFORM WEIGHTING.
 1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 140.0 HZ., 8 ELEMENTS, -0.14 DB MAX., AC:S1361, SU:S1361, UT:
 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 55.78 DEG. 3 DB BEAM, 5.62 DB AZ. GAIN, MAX. AT 220.0 DEG. HORIZ.



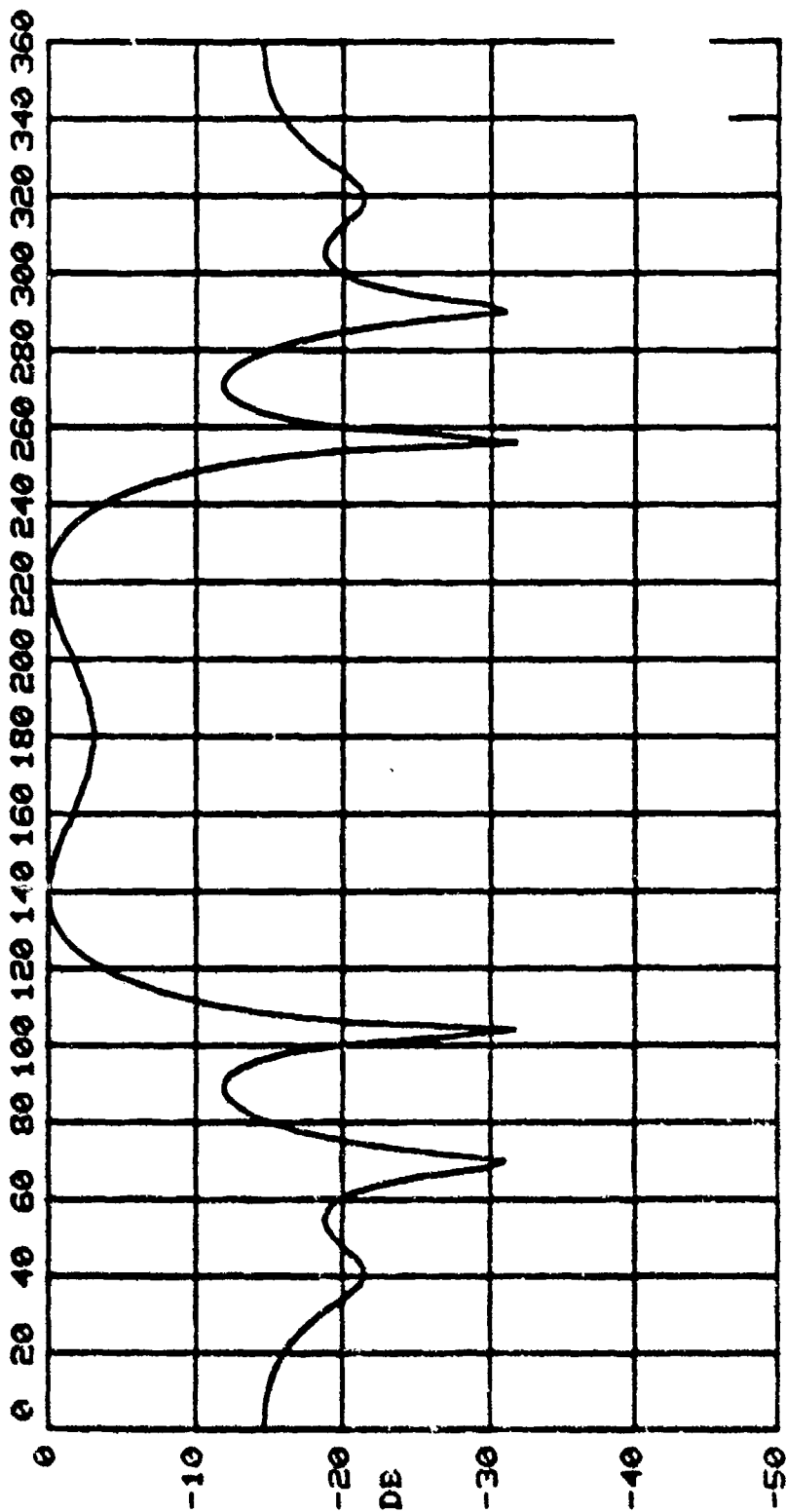
CONFIDENTIAL

Figure B-91 Theoretical Horizontal Plane Pattern for 8 Element Array @ 140 Hz for Data Point 9, 575 Off Broadside Steering. Beamwidth 55.78°, Azimuth Gain 5.62 dB.

CONFIDENTIAL

51051 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-78 UNTLEP 3.1
 : 1000 HZ. TUNED TO 300 HZ.
 : 1000 HZ. TUNED TO 300 HZ.
 : 1000 HZ. TUNED TO 300 HZ.
 : 1000 HZ. TUNED TO 300 HZ.

UNIFORM WEIGHTING.
 1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 140.0 HZ. 8 ELEMENTS, -0.14 DB MAX., AC:51361, SU:51361, UT:
 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 55.78 DEG. 3 DB BEAM, 5.62 DB AZ. GAIN, MAX. AT 220.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-92 Theoretical Horizontal Plane Pattern for 8 Element
 Array 3/40 Hz for Data Point 9, 5/5 Off Broadside
 Steering. Beamwidth 55.78°, Azimuth Gain 5.6 dB.

CONFIDENTIAL

ONTLEP 3.1

6-Jan-73

(T.HOGAN)

PROGRAM

BEAM PATTERN

TO 300 HZ.

UNIFORM SPACING

51 ELEMENTS, -0.81 DB MAX., AC:S1361, SU:S1361, UT:

90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

3.06 DEG. 3 DB BEAM, 16.20 DB AZ. GAIN, MAX. AT 141.5 DEG. HORIZ.

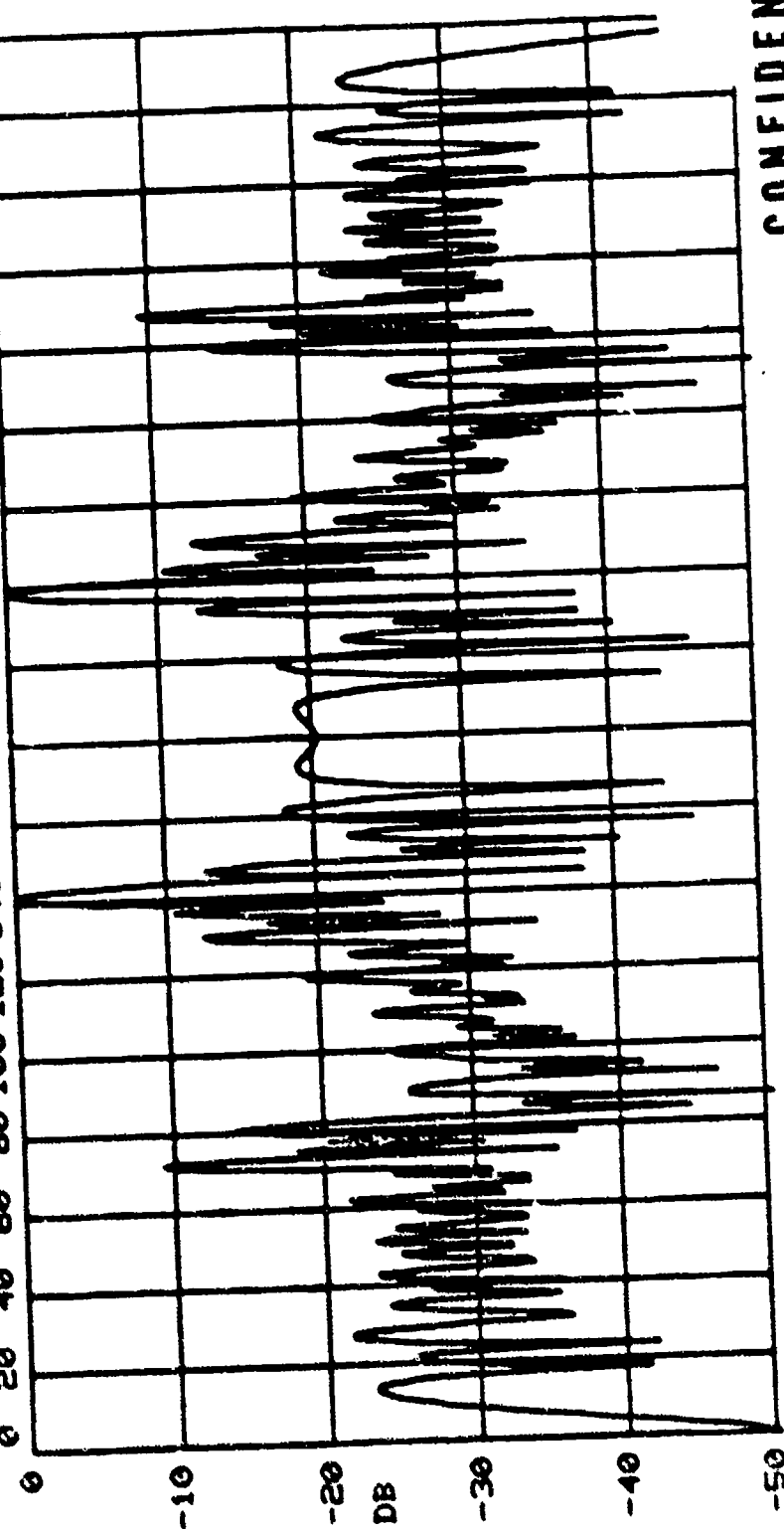
UNIFORM WEIGHTING.

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

51 ELEMENTS, -0.81 DB MAX., AC:S1361, SU:S1361, UT:

90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

3.06 DEG. 3 DB BEAM, 16.20 DB AZ. GAIN, MAX. AT 141.5 DEG. HORIZ.



CONFIDENTIAL

Figure B-93 Theoretical Horizontal Plane Pattern for 51 Element Array @ 295 Hz for Data Point 9, 57.5 Off Broadside Steering. Beamwidth 3.06°, Azimuth Gain 16.2 dB.

CONFIDENTIAL

51059 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-JAN-73 ONTLEF 3.1
 : 1.000 HZ. TUNED TO 300 HZ.
 : 1.000 HZ. UNIFORM SPACING

UNIFORM WEIGHTING.
 1.000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 235.0 HZ., 32 ELEMENTS, -0.86 DB MAX., AC:51361, SU:51361, UT:
 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 4.93 DEG. 3 DB BEAM, 14.07 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.

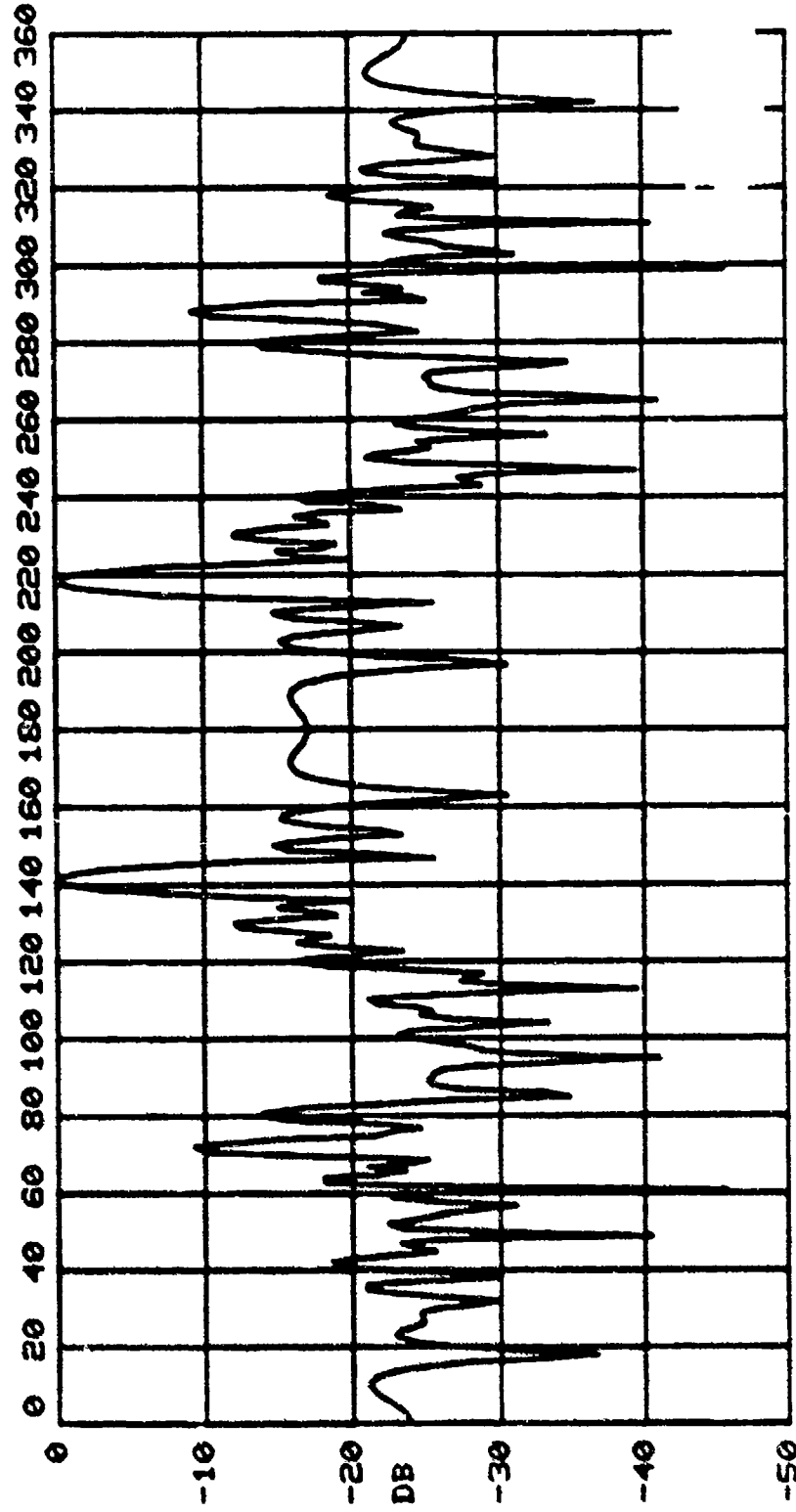


Figure B-94 Theoretical Horizontal Plane Pattern for 32 Element
 Array @ 295 Hz for Data Point 9, 9.5 Off Broadside
 Steering. Beamwidth 4.93°, Azimuth Gain 14.0 dB.

CONFIDENTIAL

CONFIDENTIAL

51056 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEP 3.1
: 0.000 HZ. TUNED TO 300 HZ.
: 1.000 FT. UNIFORM SPACING
: 0.000

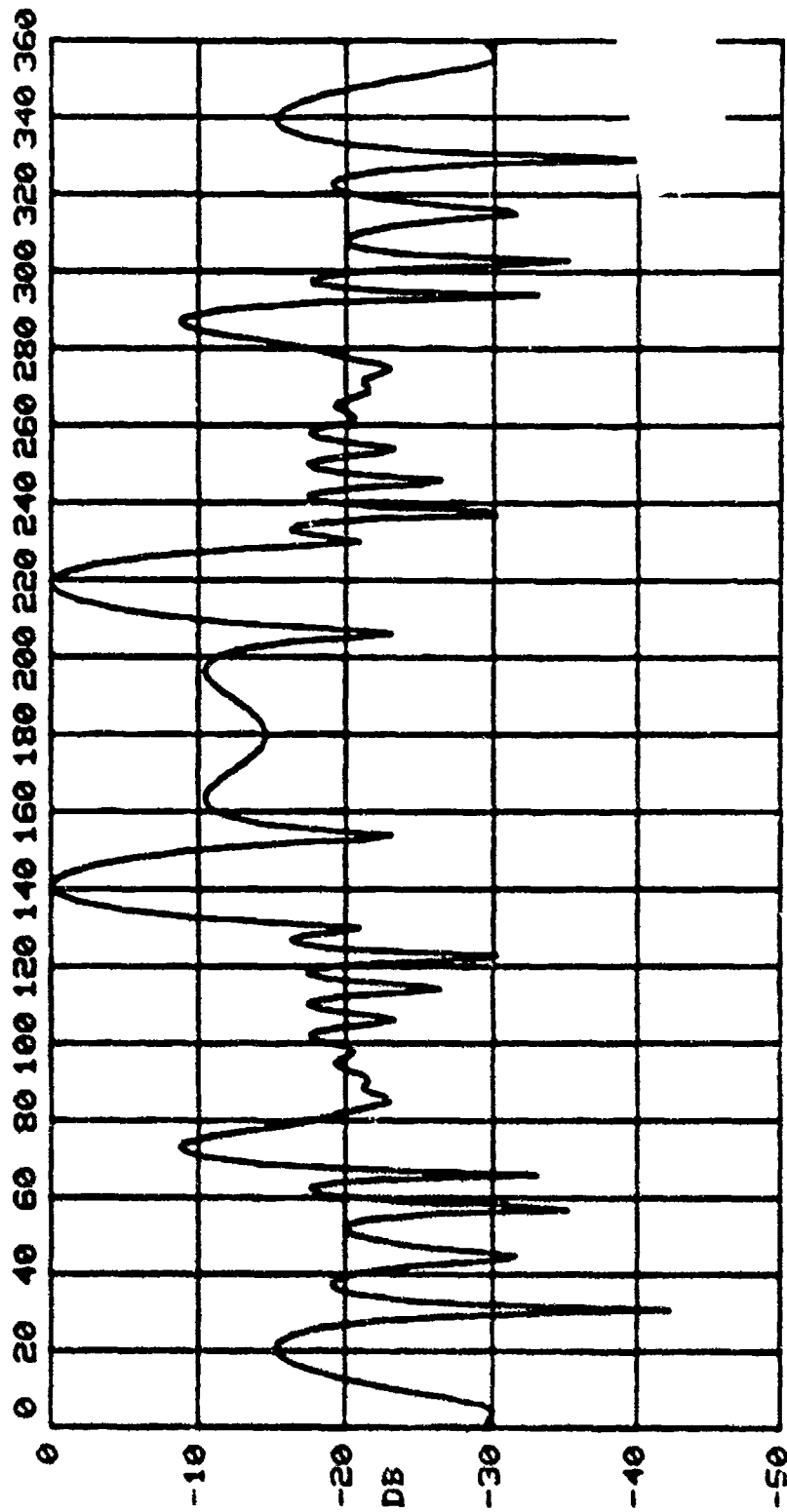
UNIFORM WEIGHTING.

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

295.0 HZ., 16 ELEMENTS, -0.75 DB MAX., AC:51361, SU:51361, WT:

90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

10.30 DEG. 3 DB BEAM, 11.05 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-95 Theoretical Horizontal Plane Pattern for 16 Element Array @ 295 Hz for Data Point 9, 51.5 Off Broadside Steering. Beamwidth 10.30°, Azimuth Gain 11.0 dB.

CONFIDENTIAL

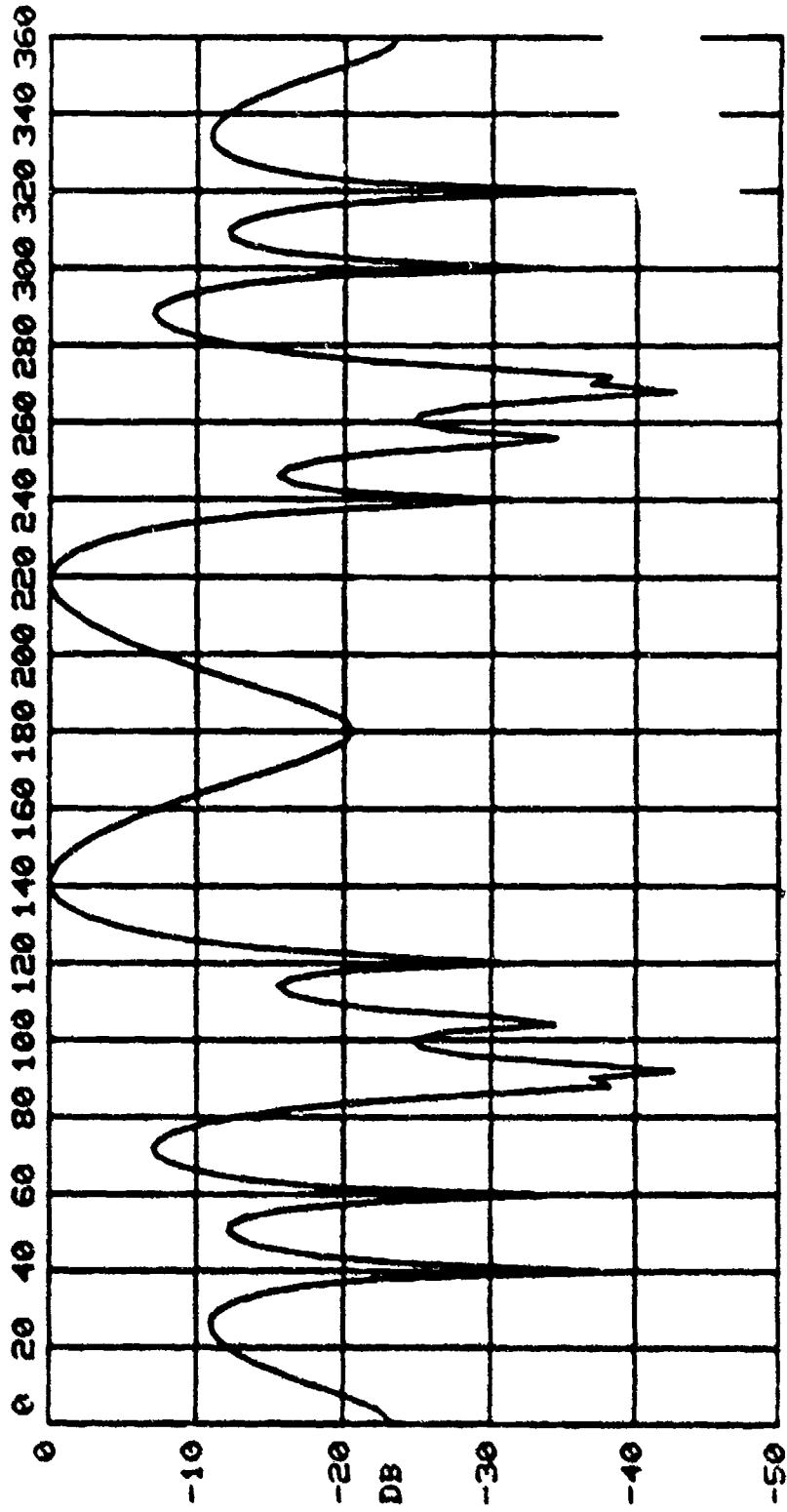
11053 E-4000S BEAM PATTERN PROGRAM (T. HOGAN) 6-Jan-73 UNTLBP 3.1
 : 11053 E-4000S TUNED TO 300 HZ.
 : 11053 E-4000S UNIFORM SPACING
 : 11053

11053
 UNIFORM WEIGHTING.

11053 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

11053 HZ. 8 ELEMENTS, -0.63 DB MAX., AC:51361, SU:51361, WT:

11053 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 21.25 DEG. 3 DB BEAM, 8.20 DB AZ. GAIN, MAX. AT 220.0 DEG. HORIZ.



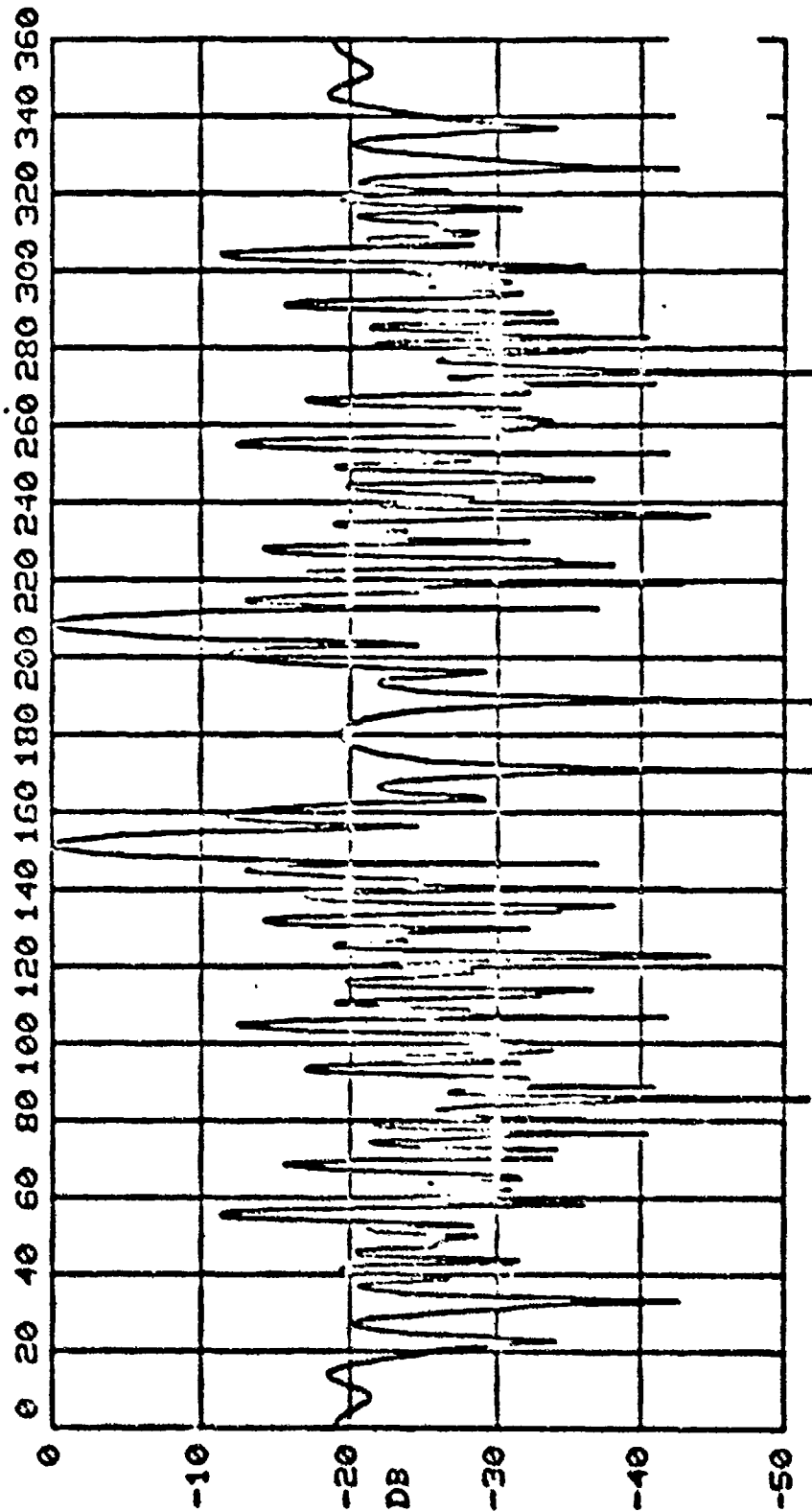
CONFIDENTIAL

Figure E-96 Theoretical Horizontal Plane Pattern for 8 Element
 Array at 295 Hz for Data Point 9, 57.5 Off Broadside
 Steering. Beamwidth 21.25°, Azimuth Gain 8.2 dB.

CONFIDENTIAL

5106B SWIFERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEF 3.1
... 300 HZ.
... UNIFORM SPACING

DP10
UNIFORM WEIGHTING.
1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
250.0 HZ., 49 ELEMENTS, -0.87 DB MAX., AC:S1362,SU:S1362,UT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.12 DEG. 3 DB BEAM, 15.00 DB AZ. GAIN, MAX. AT 208.5 DEG. HORIZ.



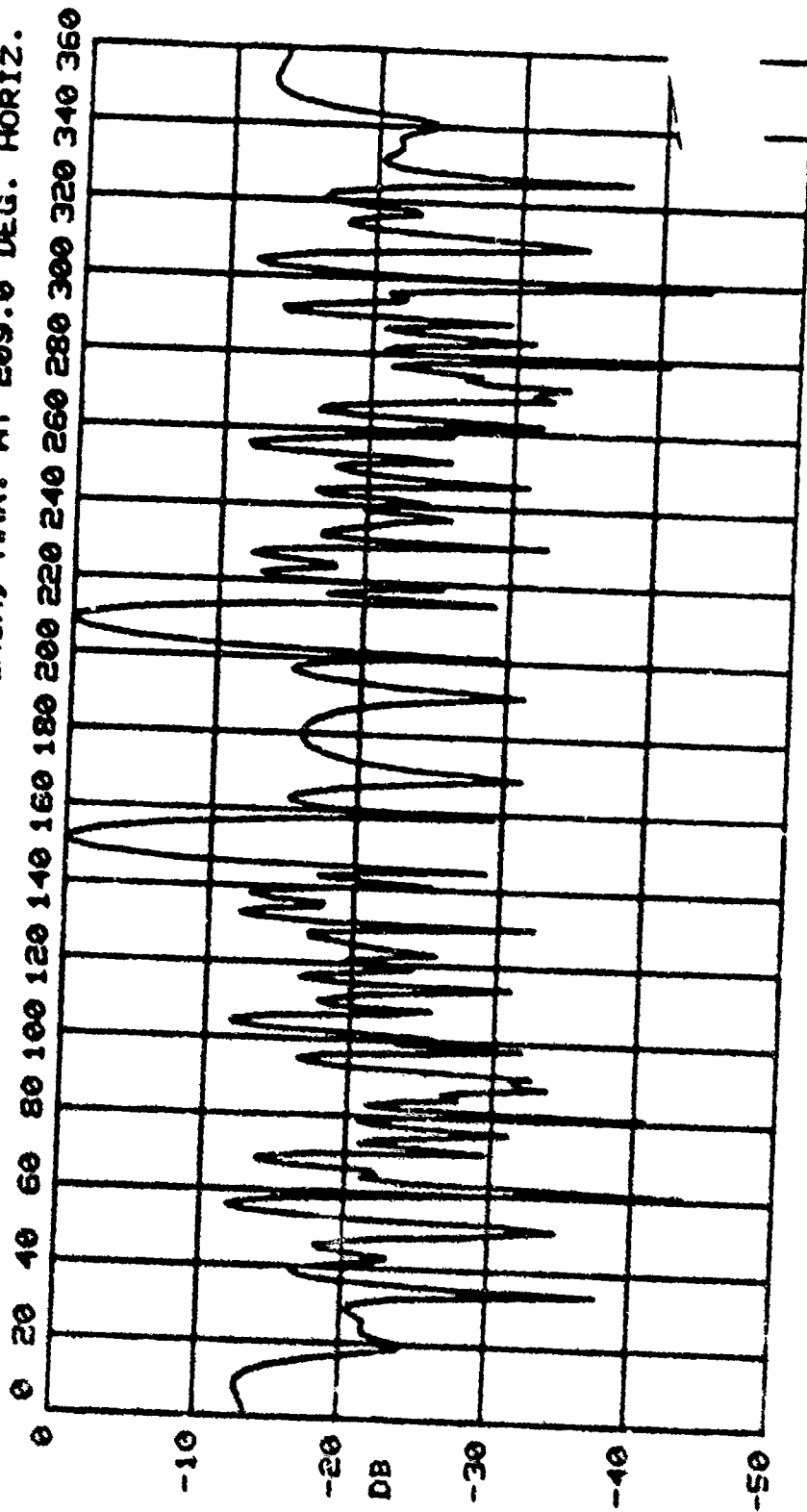
CONFIDENTIAL

Figure B-97 Theoretical Horizontal Plane Pattern for 49 Element
Array 9 250 Hz for Data Point 10, 615 Off Broadside
Steering. Beamwidth 4/12 0, Azimuth Gain 15.0 dB.

CONFIDENTIAL

51053 3-00ERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLES 3.1
 : 3-00ERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLES 3.1
 : 3-00ERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLES 3.1

UNIFORM WEIGHTING.
 1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 2000.0 HZ. 32 ELEMENTS. -0.89 DB MAX., AC:51362, SU:51362, WT:
 30.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 6.08 DEG. 3 DB BEAM, 13.04 DB AZ. GAIN, MAX. AT 209.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-98 Theoretical Horizontal Plane Pattern for 32 Element
 Array & 290 Hz for Data Point 10, 6.5 Off Broadside
 Steering. Beamwidth 6.08°, Azimuth Gain 13.0 dB.

CONFIDENTIAL

51055 CHUDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLBF 3.1

1: "CHUDERS" TUNED TO 300 HZ.

2: 2.000 FT. UNIFORM SPACING

3: 1.000

4: 1.000

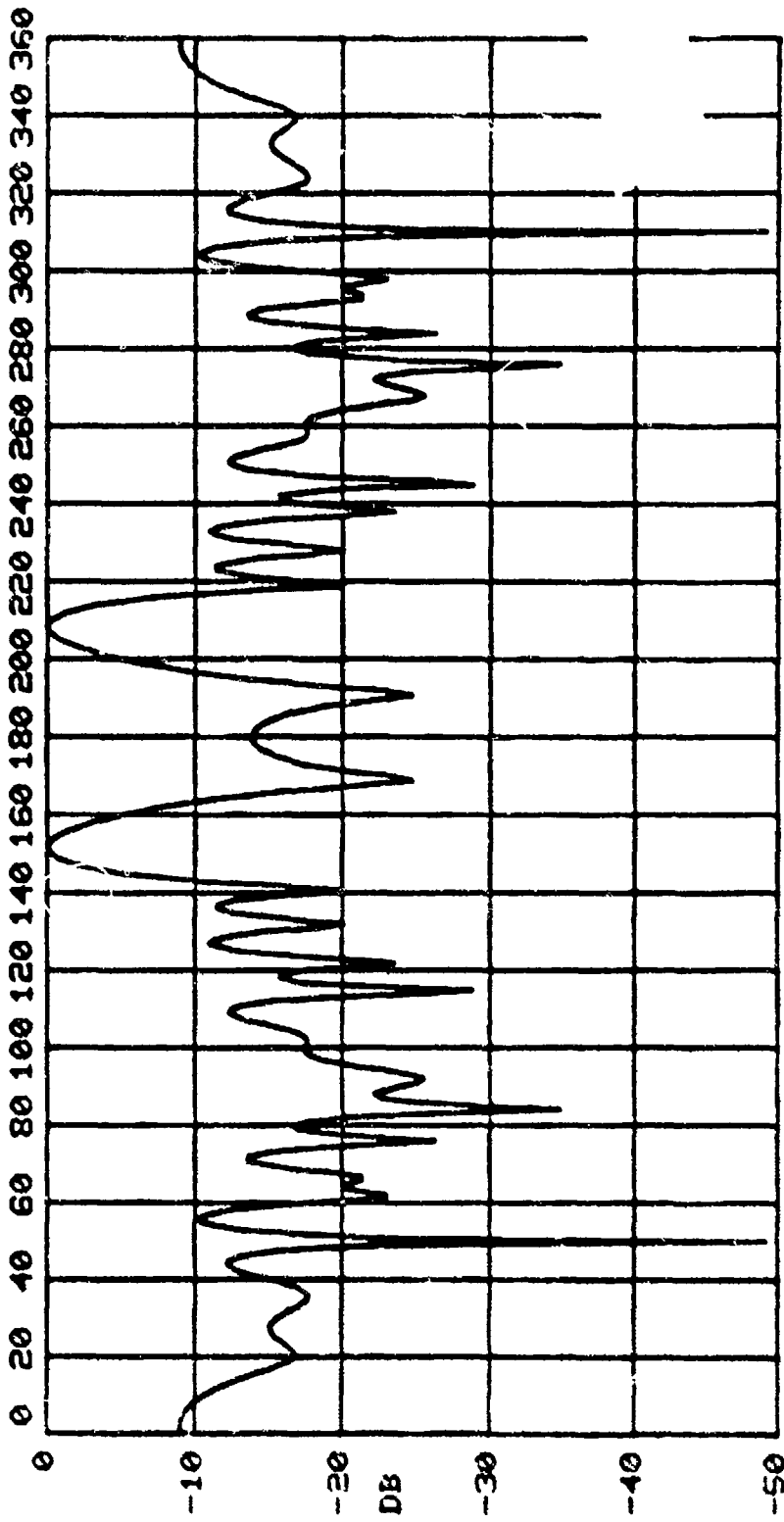
UNIFORM WEIGHTING.

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

290.0 HZ., 16 ELEMENTS, -0.79 DB MAX., AC:51362, SU:51362, UT:

90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

11.76 DEG. 3 DB BEAM, 10.15 DB AZ. GAIN, MAX. AT 152.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-99 Theoretical Horizontal Plane Pattern for 16 Element Array @ 290 Hz for Data Point 10, 0.5 Off Broadside Steering. Beamwidth 11.76°, Azimuth Gain 10.15 DB.

CONFIDENTIAL

S1062 SWIDERS FEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLP 5.1
 : 1000 HZ., TUNED TO 300 HZ.
 : 1000 HZ., TUNED TO 300 HZ.
 : 1000 HZ., TUNED TO 300 HZ.

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 230.0 HZ. 8 ELEMENTS, -0.86 DB MAX., AC:S1362, SU:S1362, WT:
 30.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 24.63 DEG. 3 DB BEAM, 6.81 DB AZ. GAIN, MAX. AT 152.0 DEG. HORIZ.

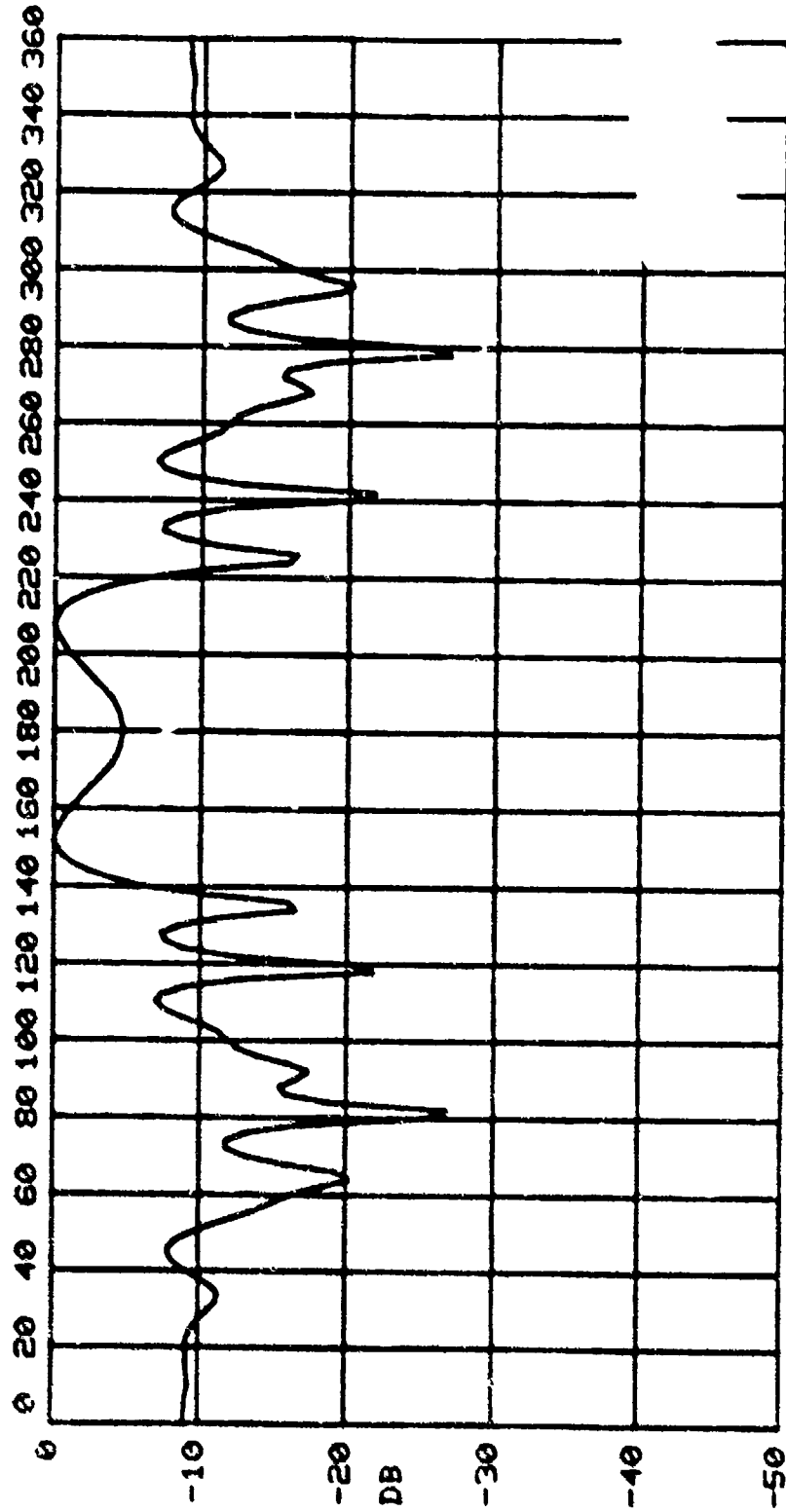


Figure B-100 Theoretical Horizontal Plane Pattern for 8 Elements
 Array & 290 Hz for Data Point 10, 615 Off Broadside
 Steering. Beamwidth 24.63°, Azimuth Gain 6.81 dB.

CONFIDENTIAL

CONFIDENTIAL

5105A 2-UTTERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 QNTLBF 3.1
: 1.000 HZ. 49 ELEMENTS, -0.22 DB MAX.. AC:51362, SU:51362, UT:
: 30.0 DEG. VERT. RESP.. 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
: 2.63 DEG. 3 DB BEAM, 12.44 DB AZ. GAIN, MAX. AT 209.0 DEG. HORIZ.

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

140.0 HZ., 49 ELEMENTS, -0.22 DB MAX.. AC:51362, SU:51362, UT:

30.0 DEG. VERT. RESP.. 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

2.63 DEG. 3 DB BEAM, 12.44 DB AZ. GAIN, MAX. AT 209.0 DEG. HORIZ.

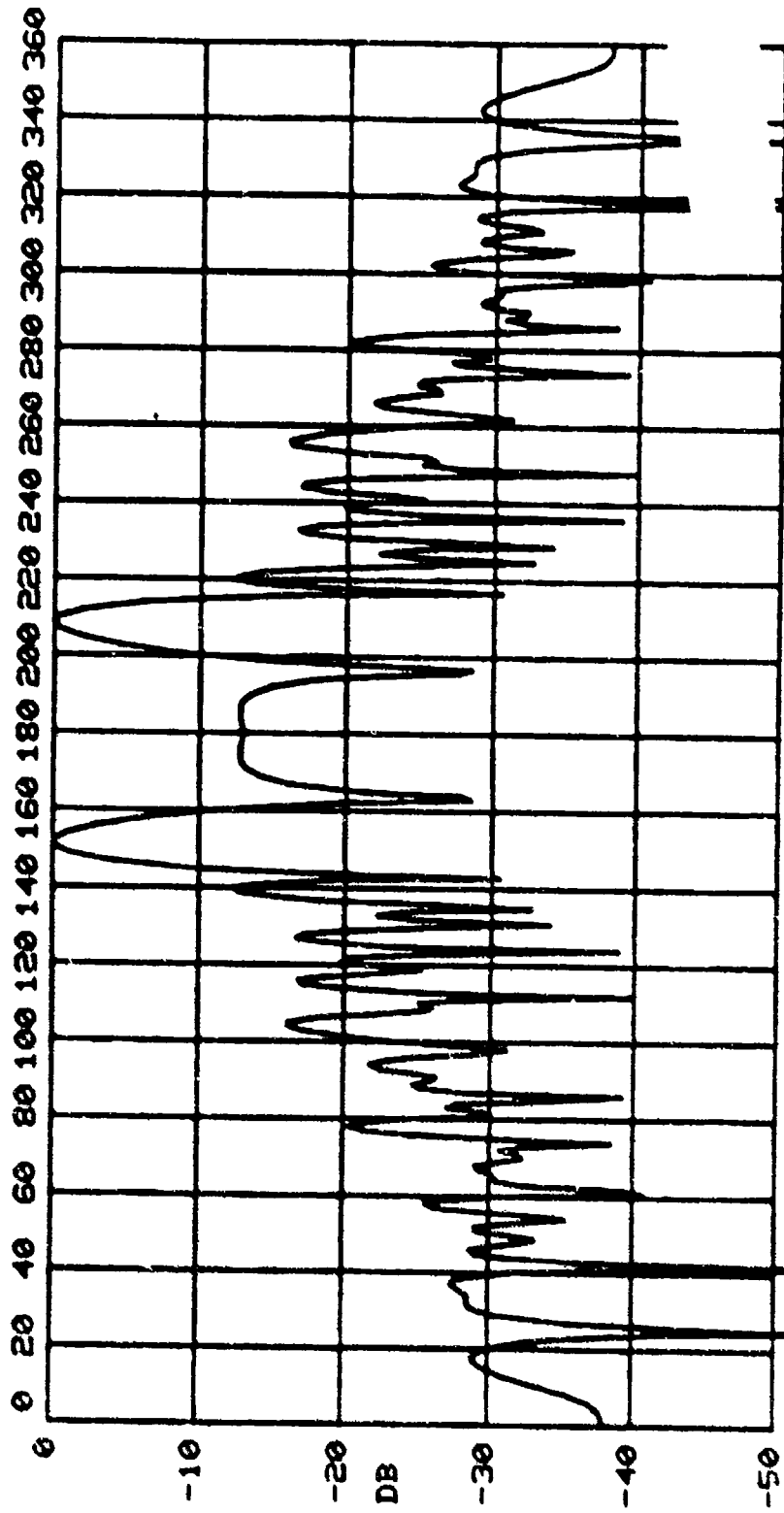


Figure B-101 Theoretical Horizontal Plane Pattern for 49 Element
Array & 140 Hz for Data Point 10, 0.65 Off Broadside
Steering. Beamwidth 8.63°, Azimuth Gain 12.4 dB.

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51067 3-100ERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 QNTLEP 3.1
 : 1000 HZ. 32 ELEMENTS, -0.20 DB MAX., AC:51362, SU:51362, UT:
 : 1000 HZ. 32 ELEMENTS, -0.20 DB MAX., AC:51362, SU:51362, UT:
 : 1000 HZ. 32 ELEMENTS, -0.20 DB MAX., AC:51362, SU:51362, UT:

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 140.0 HZ., 32 ELEMENTS, -0.20 DB MAX., AC:51362, SU:51362, UT:
 90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 13.05 DEG. 3 DB BEAM, 10.84 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.

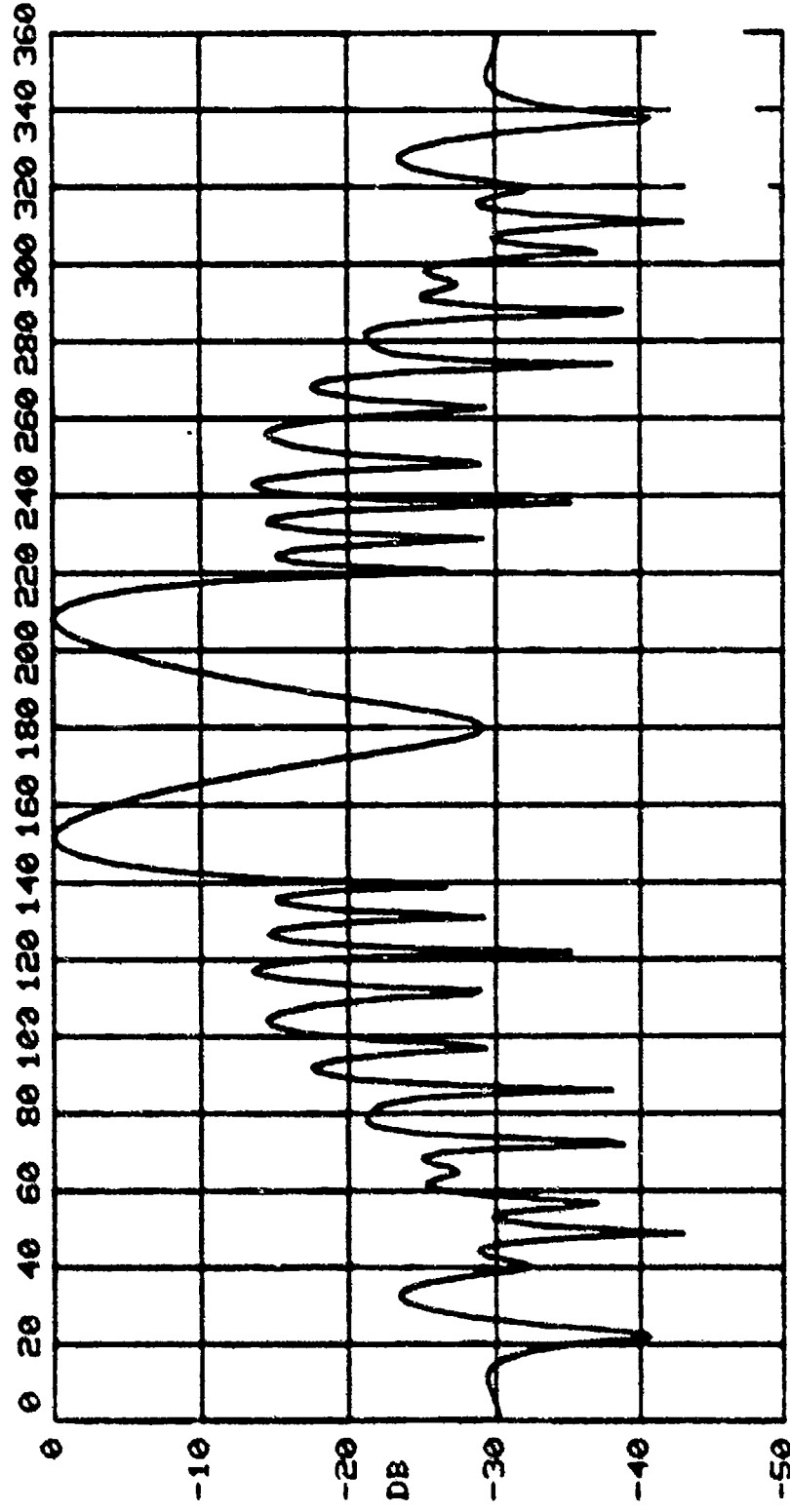


Figure B-102 Theoretical Horizontal Plane Pattern for 32 Element
 Array & 140 Hz for Data Point 10, 05 Off Broadside
 Steering. Beamwidth 13.05°, Azimuth Gain 10.8 dB.

CONFIDENTIAL

CONFIDENTIAL

S1064 SMIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-JAN-73 QNTLBP 3.1

.. .. . TUNED TO 300 MC.

3.2.2.2. UNIFORM SPACING

22

2

UNIFORM WEIGHTING.

1.500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

140.0 HZ., 16 ELEMENTS, -0.19 DB MAX., AC:S1362, SU:S1362, WT:

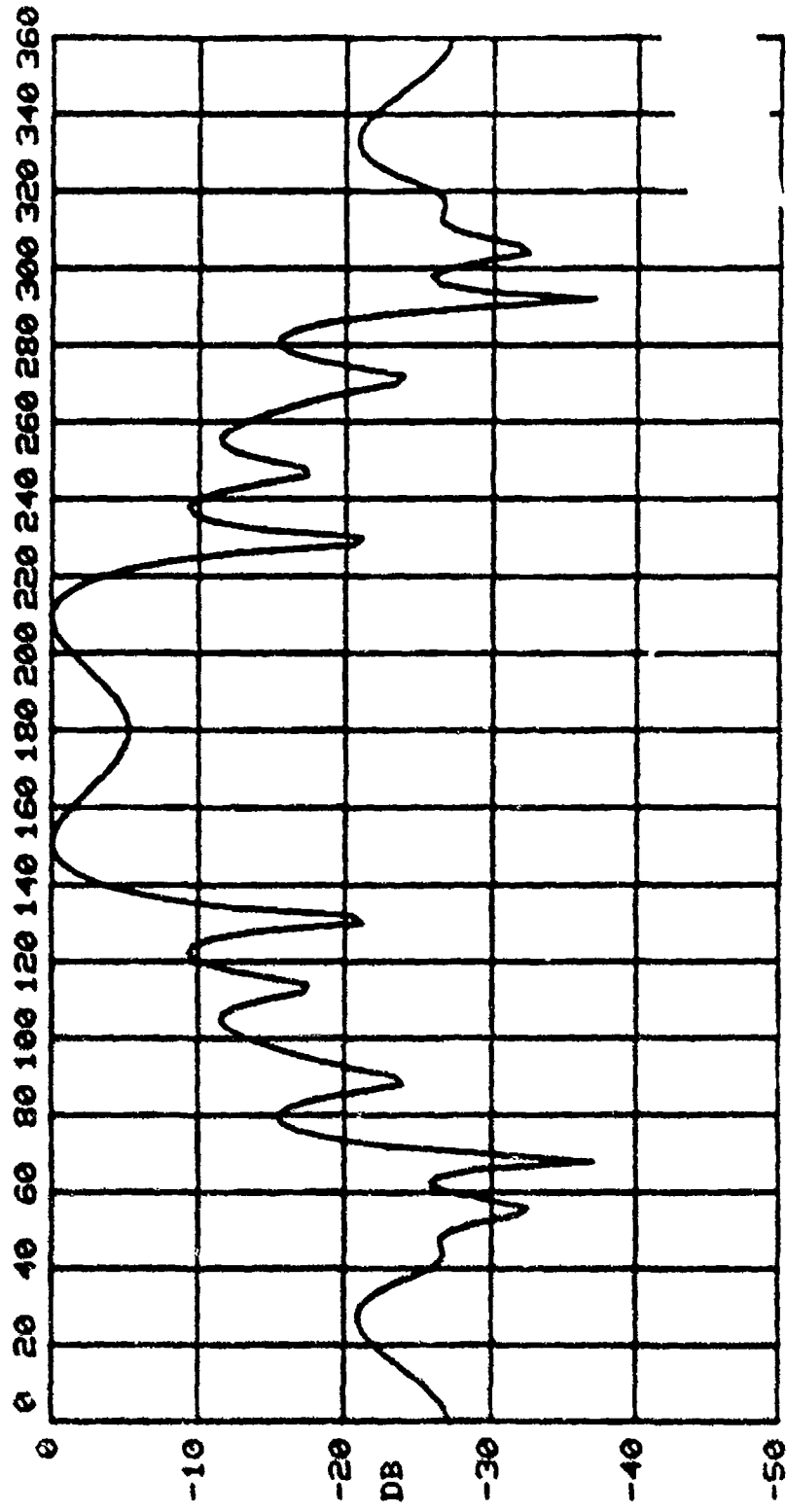


Figure E-103 Theoretical Horizontal Plane Pattern for 16 Element Array ± 140 Hz for Data Point 10, 61.5 Off Broadside Steering. Beamwidth 25.9° , Azimuth Gain 7.7 dB.

CONFIDENTIAL

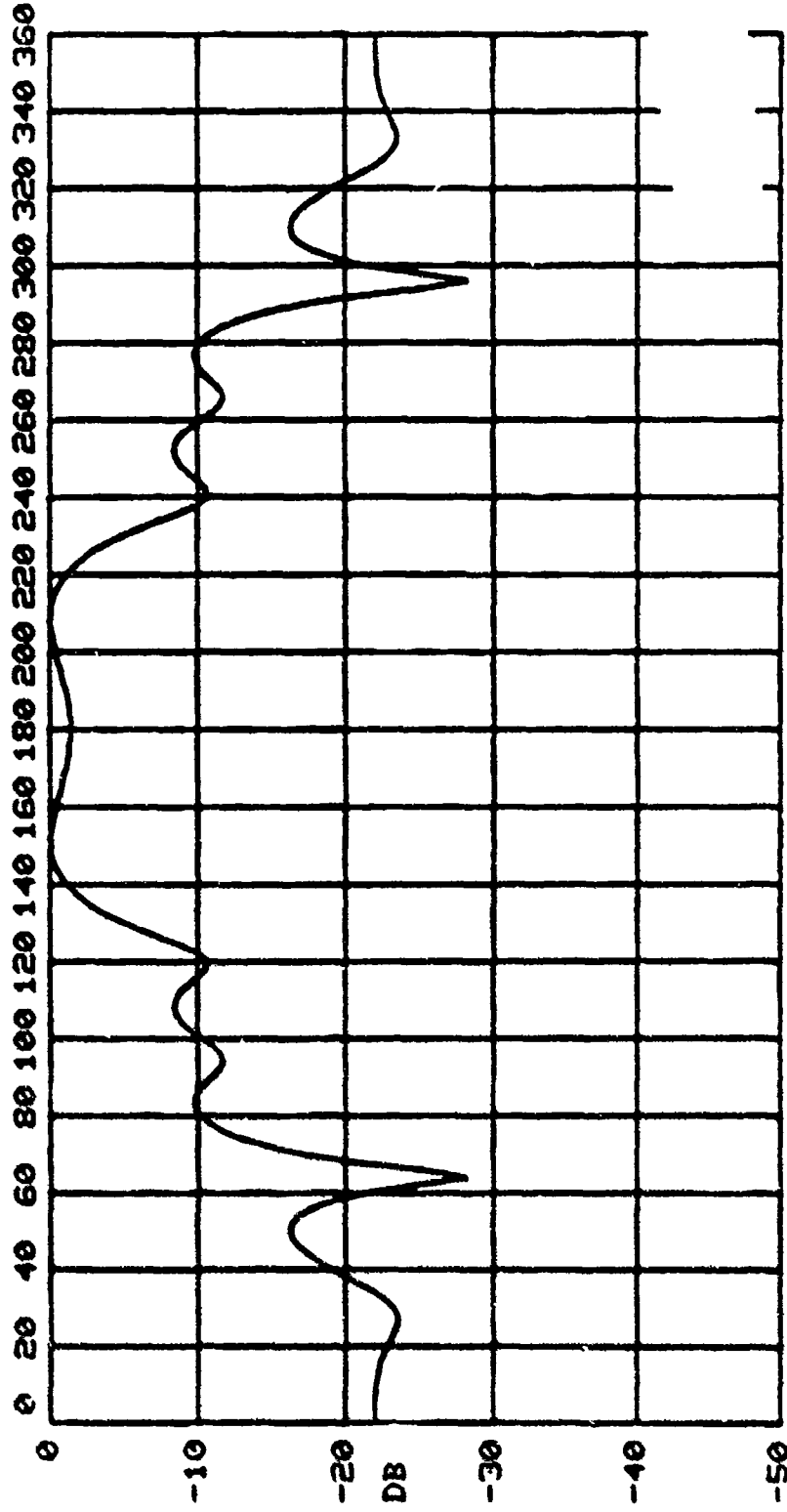
CONFIDENTIAL

51061 EMBERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEP 3.1
 : 100 HZ. TUNED TO 200 HZ.
 : 1000 FT. UNIFORM SPACING

1/ 10

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 140.0 HZ. 8 ELEMENTS, -0.20 DB MAX., AC:51362, SU:51362, WT:
 90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 92.49 DEG. 3 DB BEAM, 5.76 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.



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Figure B-104 Theoretical Horizontal Plane Pattern for 8 Element
 Array @ 140 Hz for Data Point 10, 1/5 Off Broadside
 Steering. Beamwidth 92.49°, Azimuth Gain 5.7 dB.

CONFIDENTIAL

S1050 BANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 QNTLBP 3.1
 : 1000 HZ. TUNED TO 300 HZ.
 : 1000 HZ. UNIFORM SPACING
 : 1000

SPR

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

105.0 HZ. 49 ELEMENTS, -0.85 DB MAX., AC:S1362, SU:S1362, UT:

90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 4.04 DEG. 3 DB BEAM, 15.04 DB AZ. GAIN, MAX. AT 208.5 DEG. HORIZ.

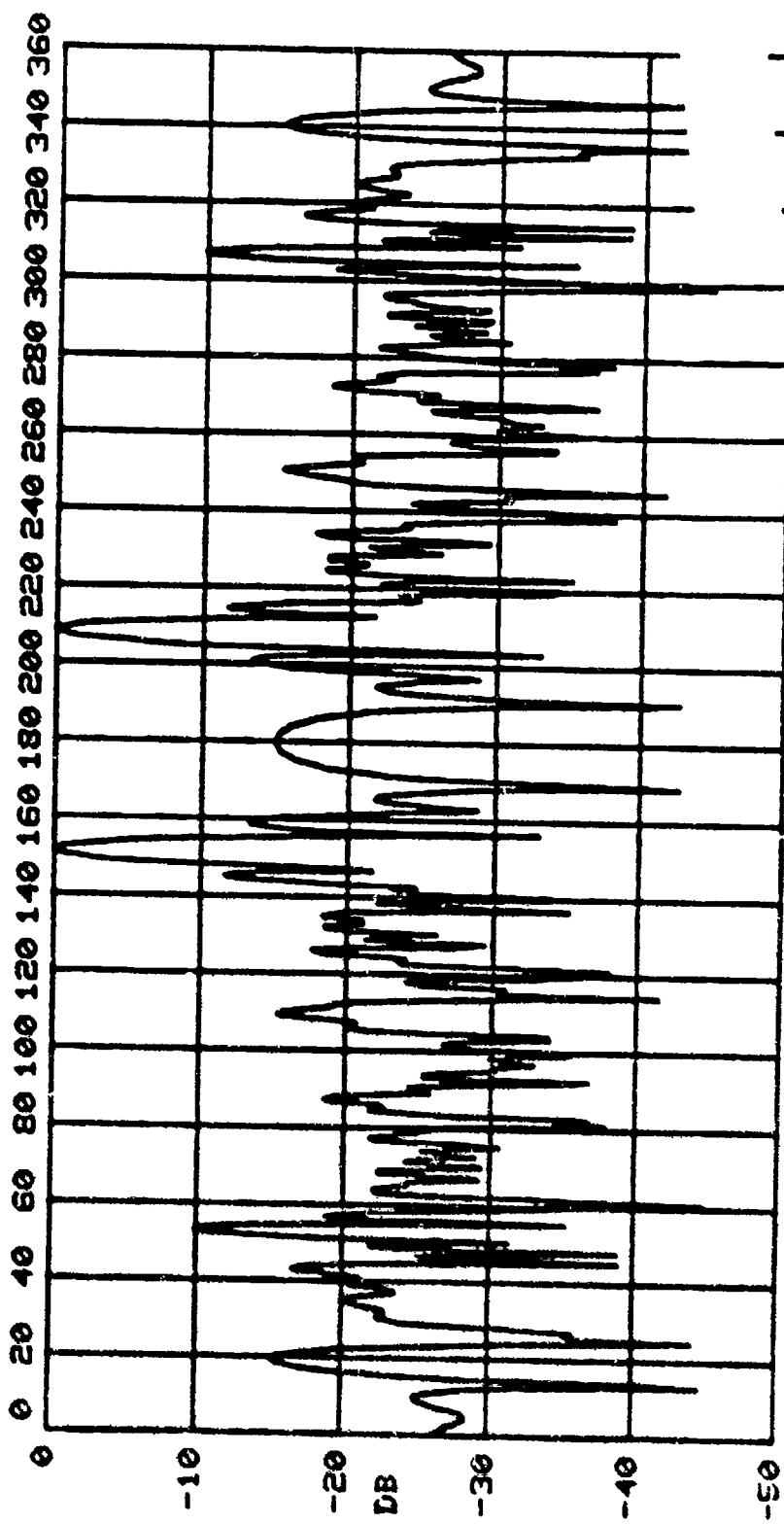


Figure B-105 Theoretical Horizontal Plane Pattern for 49 Element
 Array @ 295 Hz for Data Point 10, 615 Off Broadside
 Steering. Beamwidth 4.04°, Azimuth Gain 15.0 dB.

CONFIDENTIAL

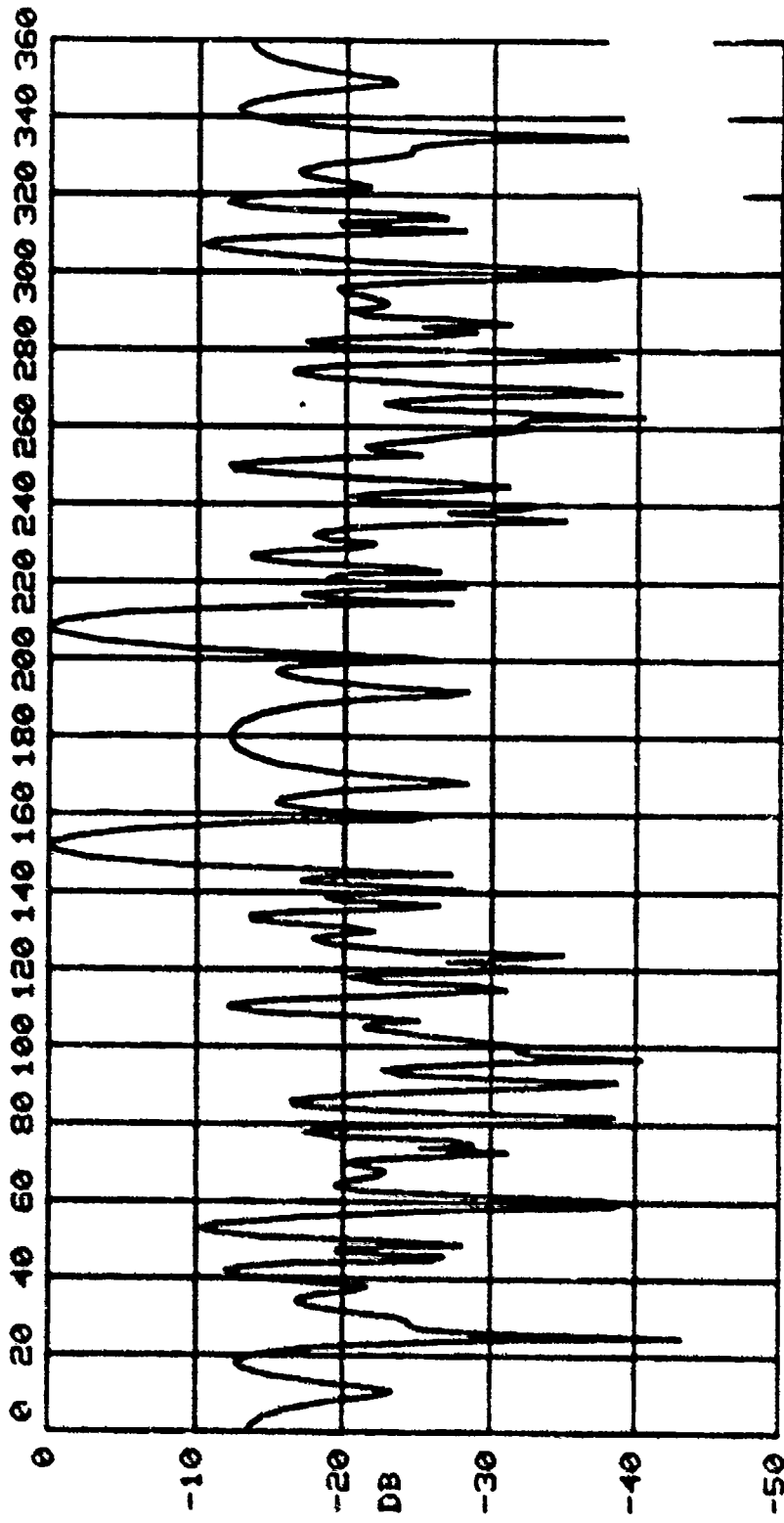
CONFIDENTIAL

51069 3-1000 BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 UNTLBP 3.1
 : 1000 HZ. ARRAY TUNED TO 300 HZ.
 : 1000 HZ. UNIFORM SPACING

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

1000 HZ. 32 ELEMENTS, -0.92 DB MAX., AC:51362, SU:51362, UT:
 90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 6.08 DEG. 3 DB BEAM, 13.02 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.



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Figure B-106 Theoretical Horizontal Plane Pattern for 32 Element
 Array at 295 Hz for Data Point 10, 615 Off Broadside
 Steering. Beamwidth 6.08°, Azimuth Gain 13.0 dB.

CONFIDENTIAL

51053 SWIERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-78 ONTLEP 3.1
 : 1000 HZ. TUNED TO 300 HZ.
 : 1000 FT. UNIFORM SPACING
 : 01/10

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 395.0 HZ., 8 ELEMENTS, -0.57 DB MAX., AC:S1362, SU:S1362, UT:
 90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 28.95 DEG. 3 DB BEAM, 6.86 DB AZ. GAIN, MAX. AT 154.0 DEG. HORIZ.

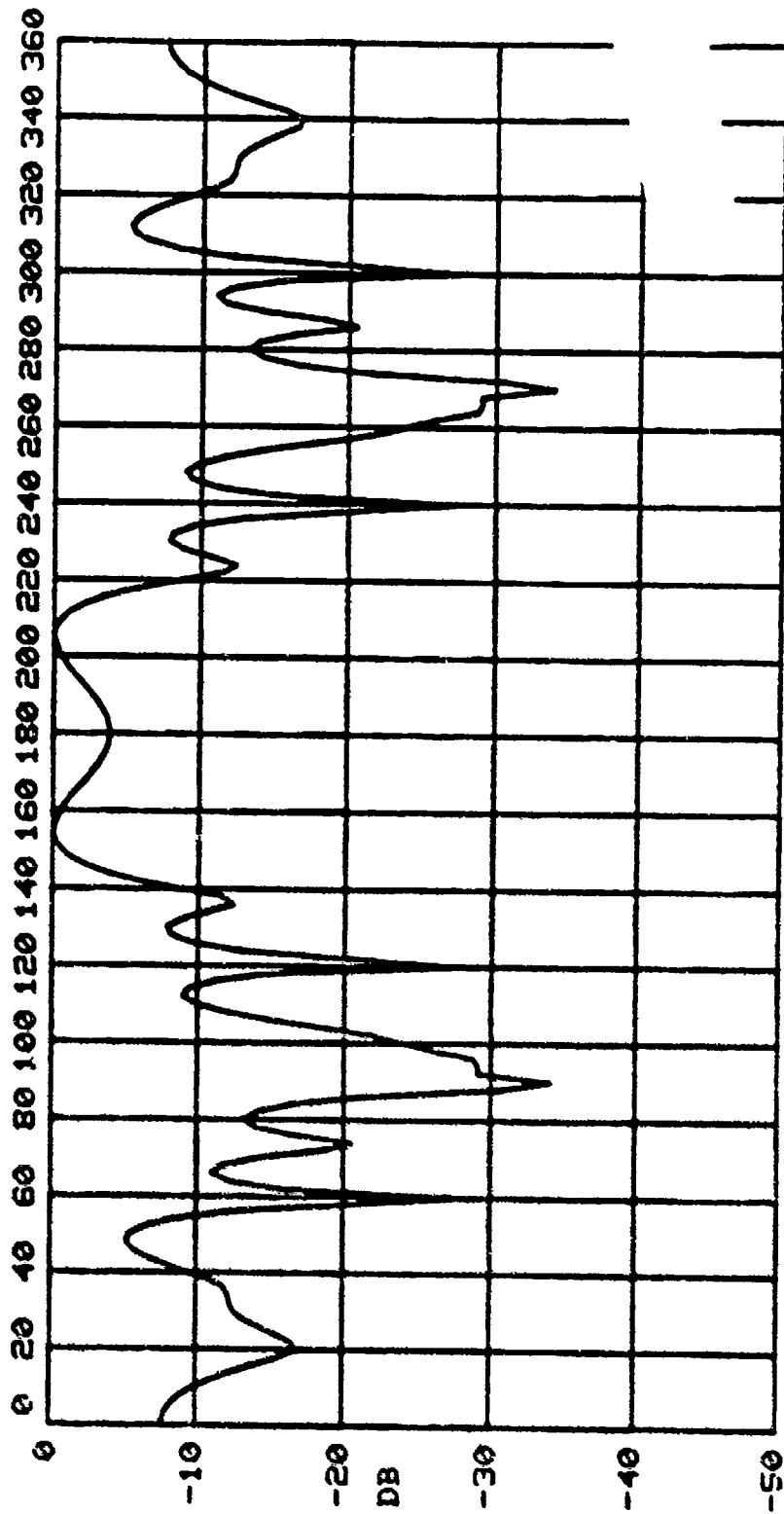


Figure B-108 Theoretical Horizontal Plane Pattern for 8 Element Array @ 295 Hz for Data Point 10, 6.5 Off Broadside Steering. Beamwidth 26.15°, Azimuth Gain 6.8 dB.

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CONFIDENTIAL

54.20 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
: 1000 HZ. ARRAY TUNED TO 300 HZ.
: 2.1233 FT. UNIFORM SPACING.
: END

DATA POINT 11
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
200.0 HZ., 51 ELEMENTS, -0.83 DB MAX., AC:S2581, SU:S2581, UT:
90.0 DEG. VERT. RESP., 154.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.45 DEG. 3 DB BEAM, 14.85 DB AZ. GAIN, MAX. AT 206.0 DEG. HORIZ.

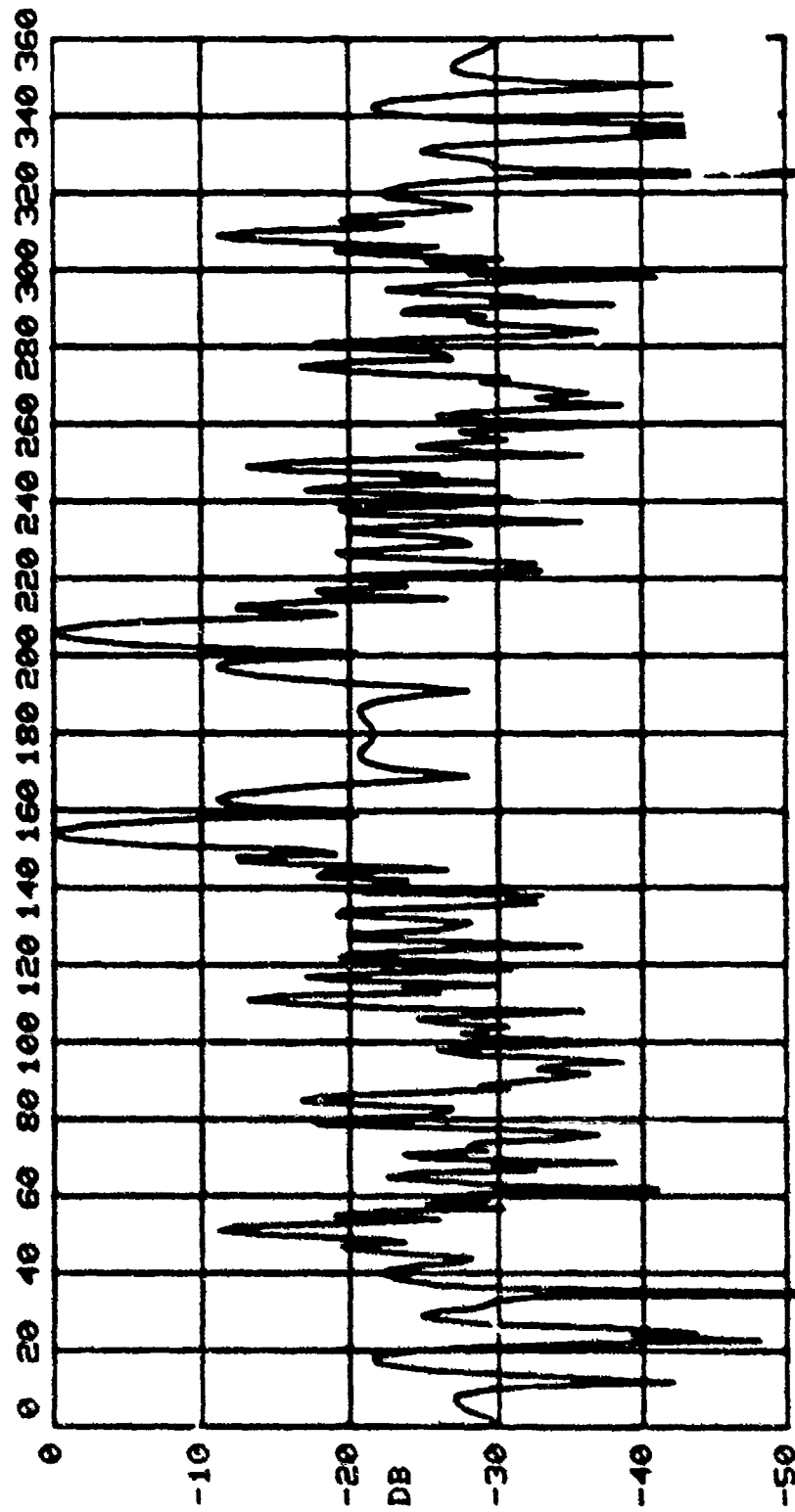


Figure B-109 Theoretical Horizontal Plane Pattern for 51 Element
Array at 200 HZ for Data Point 11, 64 Off Broadside
Steering. Beamwidth 4.45°, Azimuth Gain 14.8 dB.

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CONFIDENTIAL

14.25 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 QNTLEP 3.1
.. 10000 HZ. ARRAY TUNED TO 300 HZ.
.. 10000 FT. UNIFORM SPACING.
.. 5000

DATA POINT 11
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
200.0 HZ., 32 ELEMENTS, -0.73 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 153.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
5.86 DEG. 3 DB BEAM, 13.01 DB AZ. GAIN, MAX. AT 153.0 DEG. HORIZ.

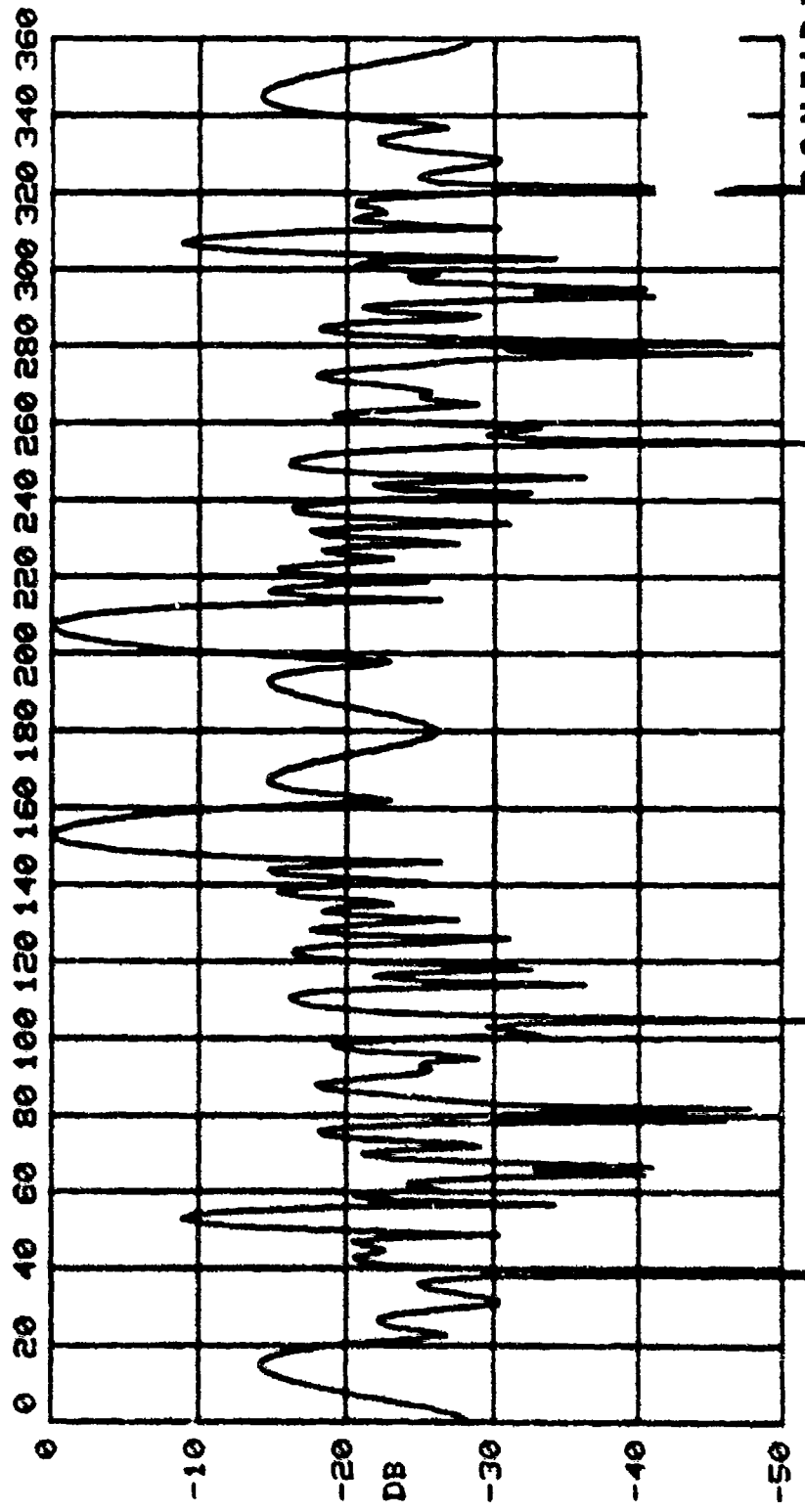


Figure B-110 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 290 Hz for Data Point 11, 63 Off Broadside
Steering. Beamwidth 6.86°, Azimuth Gain 13.0 dB.

CONFIDENTIAL

CONFIDENTIAL

34020 SAIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 QNTLBP 3.1
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
230.0 HZ., 16 ELEMENTS, -0.78 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 154.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
15.34 DEG. 3 DB BEAM, 9.43 DB AZ. GAIN, MAX. AT 206.0 DEG. HORIZ.

DATA POINT 11

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

230.0 HZ., 16 ELEMENTS, -0.78 DB MAX., AC:52581, SU:52581, WT:

90.0 DEG. VERT. RESP., 154.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

15.34 DEG. 3 DB BEAM, 9.43 DB AZ. GAIN, MAX. AT 206.0 DEG. HORIZ.

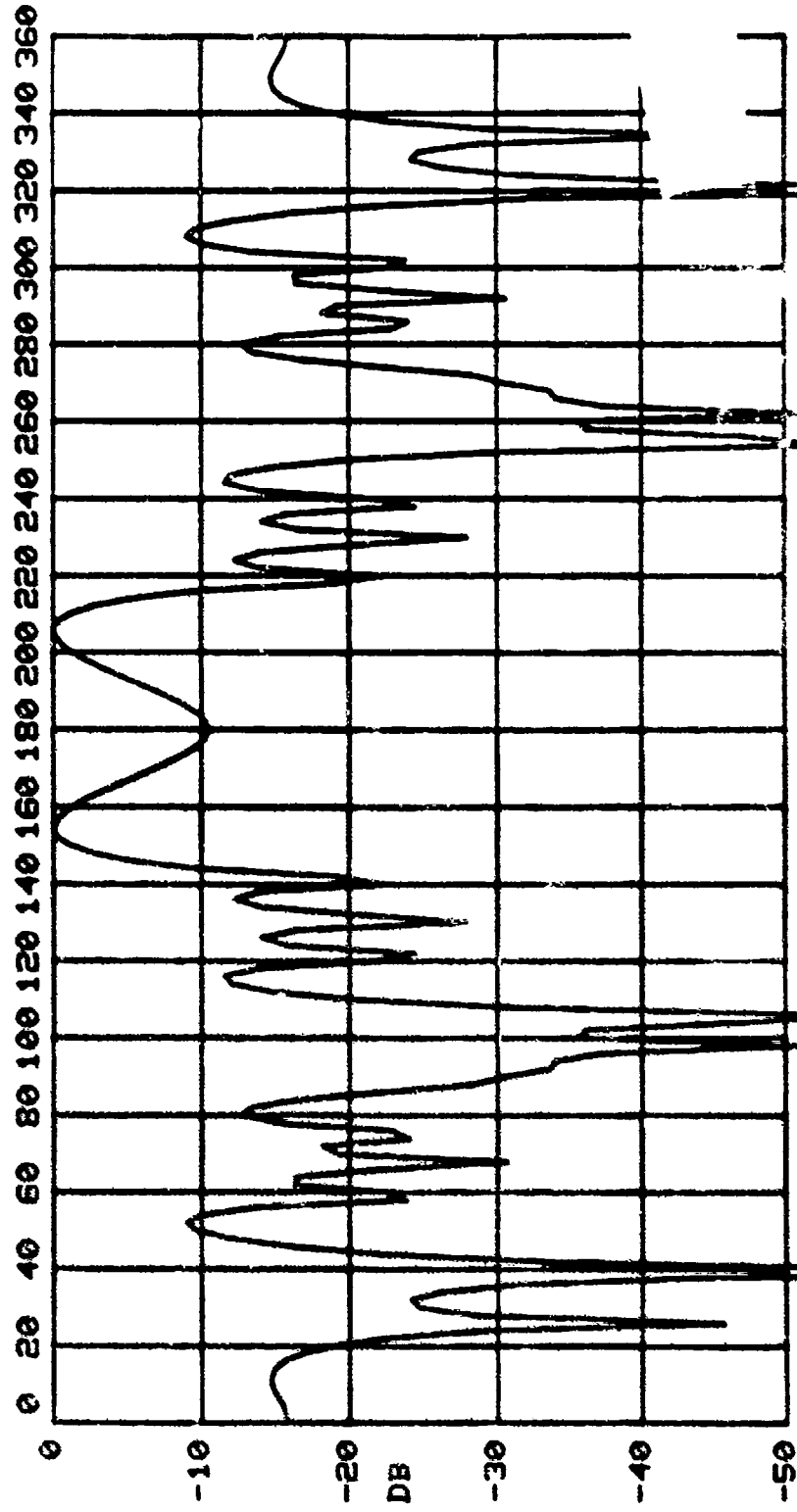


Figure B-III Theoretical Horizontal Plane Pattern for 16 Element
Array @ 230 Hz for Data Point 11, 64 Off Broadside
Steering. Beamwidth 5.94°, Azimuth Gain 9.4 dB.

CONFIDENTIAL

CONFIDENTIAL

5402T SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLRP 3.1

... 5402T ARRAY TUNED TO 300 HZ.

... 5.3233 FT. UNIFORM SPACING.

... 5.3233

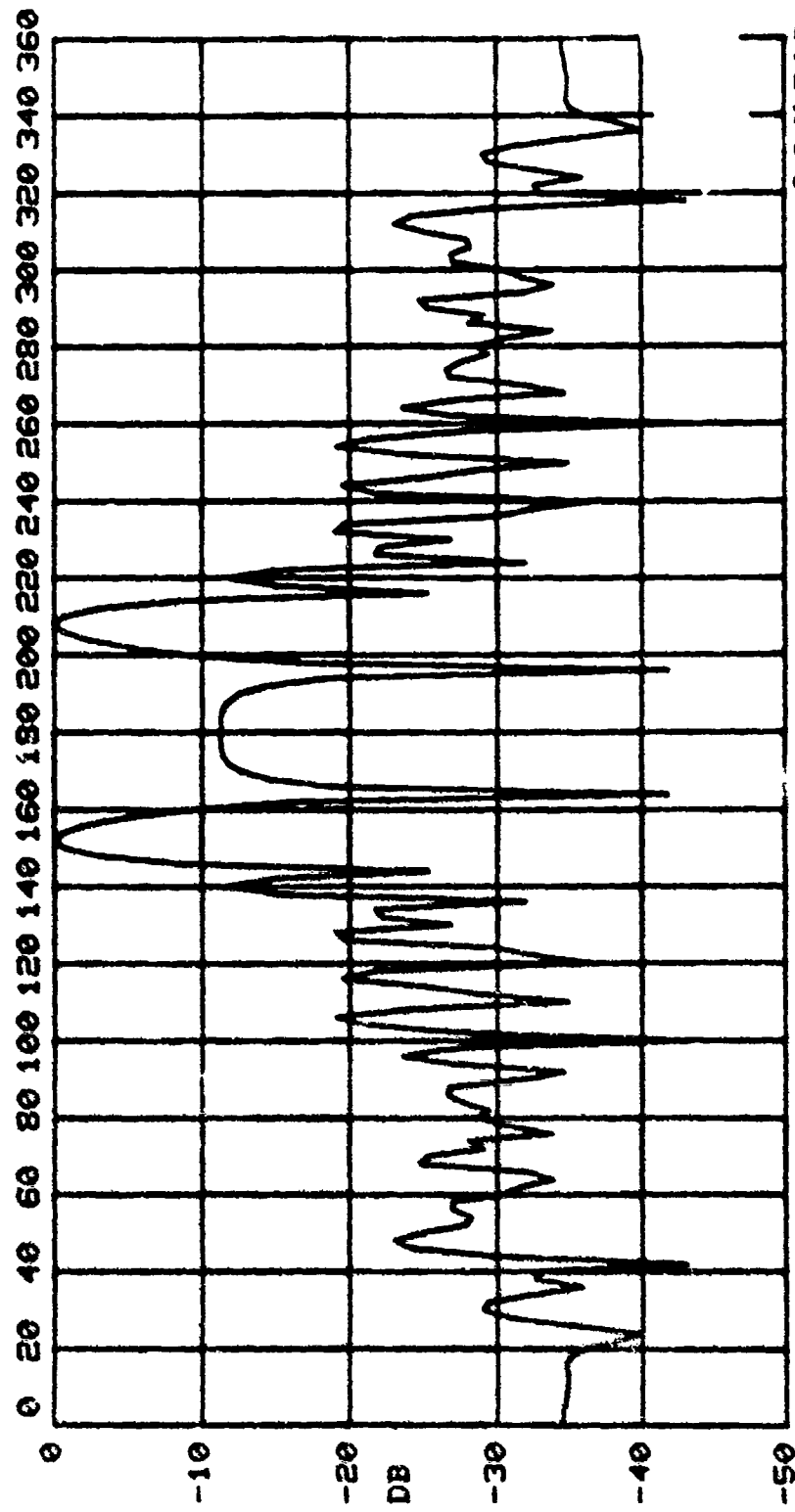
DATA POINT 11

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

140.0 HZ., 51 ELEMENTS, -0.18 DB MAX., AC:52581, SU:52581, WT:

90.0 DEG. VERT. RESP., 152.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

8.69 DEG. 3 DB BEAM, 12.42 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.



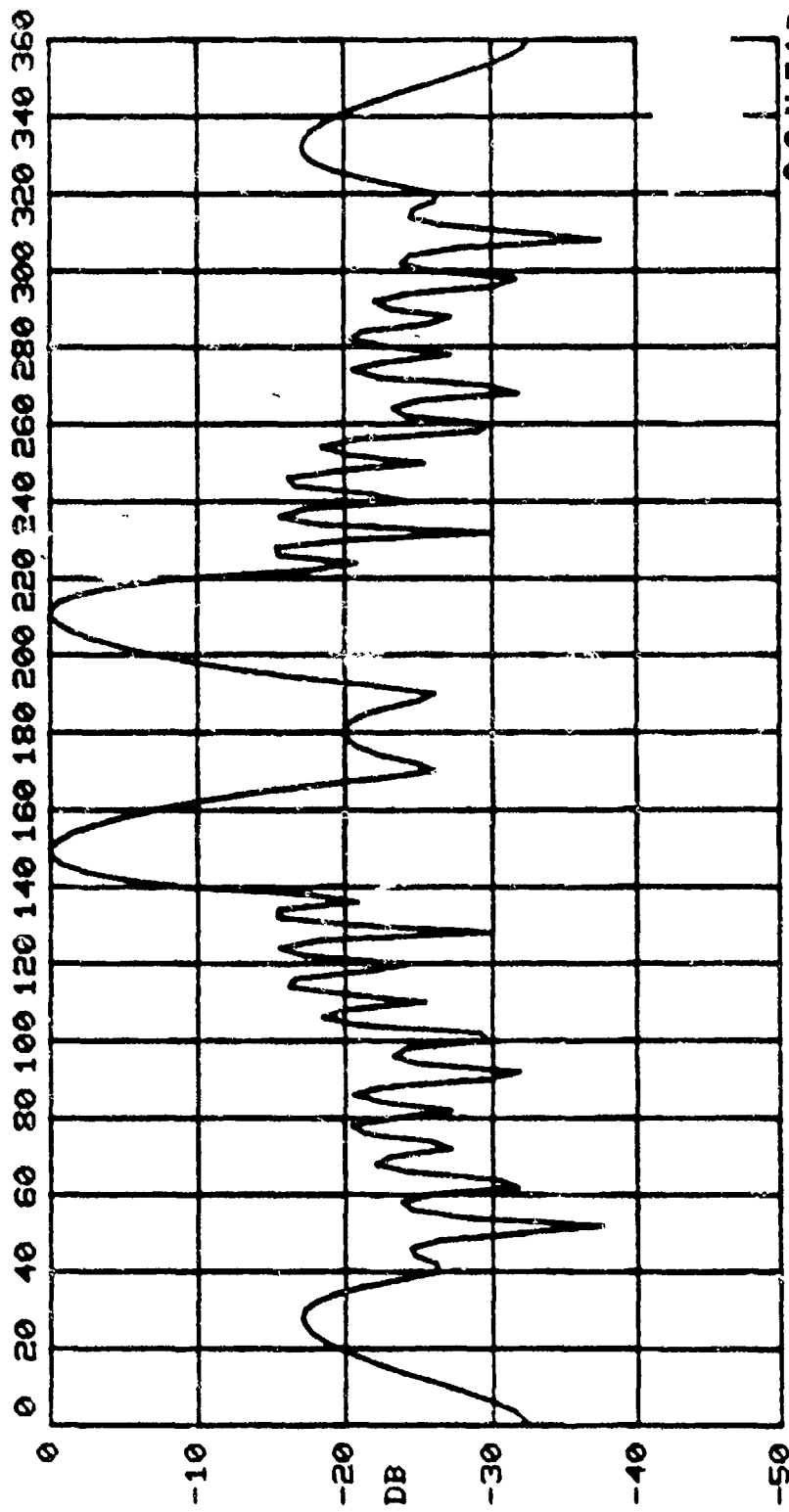
CONFIDENTIAL

Figure 8-112 Theoretical Horizontal Plane Pattern for 5/ Element Array 3/40 Hz for Data Point 11, 62 Off Broadside Steering. Beamwidth 8.69°, Azimuth Gain 12.42 dB.

CONFIDENTIAL

SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLEP 3.1
ARRAY TUNED TO 300 HZ.
1.3223 FT. UNIFORM SPACING.
END

DATA POINT 11
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 32 ELEMENTS, -0.31 DB MAX., AC:S2581, SU:S2581, WT:
90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
12.90 DEG. 3 DB BEAM, 10.91 DB AZ. GAIN, MAX. AT 150.0 DEG. HORIZ.



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Figure B-113 Theoretical Horizontal Plane Pattern for 32-Element Array @ 140 Hz for Data Point 11, 59 Off Broadside Steering. Beamwidth 12.90, Azimuth Gain 10.9 dB.

CONFIDENTIAL

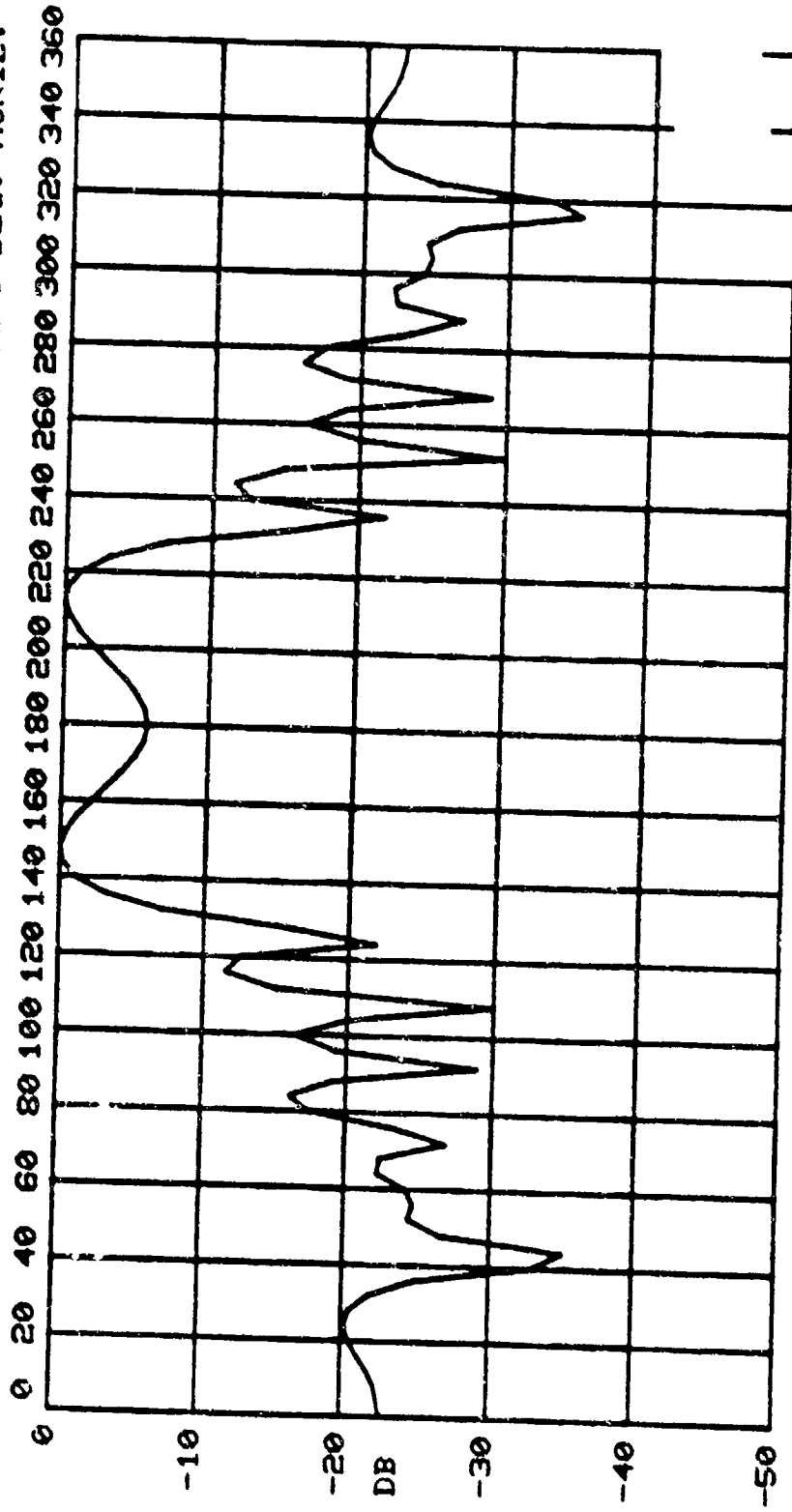
54122 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
--: ARRAY ARRAY TUNED TO 300 HZ.
3.3333 FT. UNIFORM SPACING.
3: SAME

DATA POINT 11

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

140.0 HZ., 16 ELEMENTS, -0.19 DB MAX., AC:52581, SU:52581, WT:

90.0 DEG. VERT. RESP., 147.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
27.48 DEG. 3 DB BEAM, 7.63 DB AZ. GAIN, MAX. AT 212.0 DEG. HORIZ.



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Figure B-114 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 140 Hz for Data Point 11, 57 Off Broadside
Steering. Beamwidth 27.48°, Azimuth Gain 7.6 dB.

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52353 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 QNTLBP 3.1
1: SPREAD ARRAY TUNED TO 300 HZ.
2: 3233 FT. UNIFORM SPACING.
3: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
290.0 HZ., 51 ELEMENTS, -0.81 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 90.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.14 DEG. 3 DB BEAM, 15.15 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.

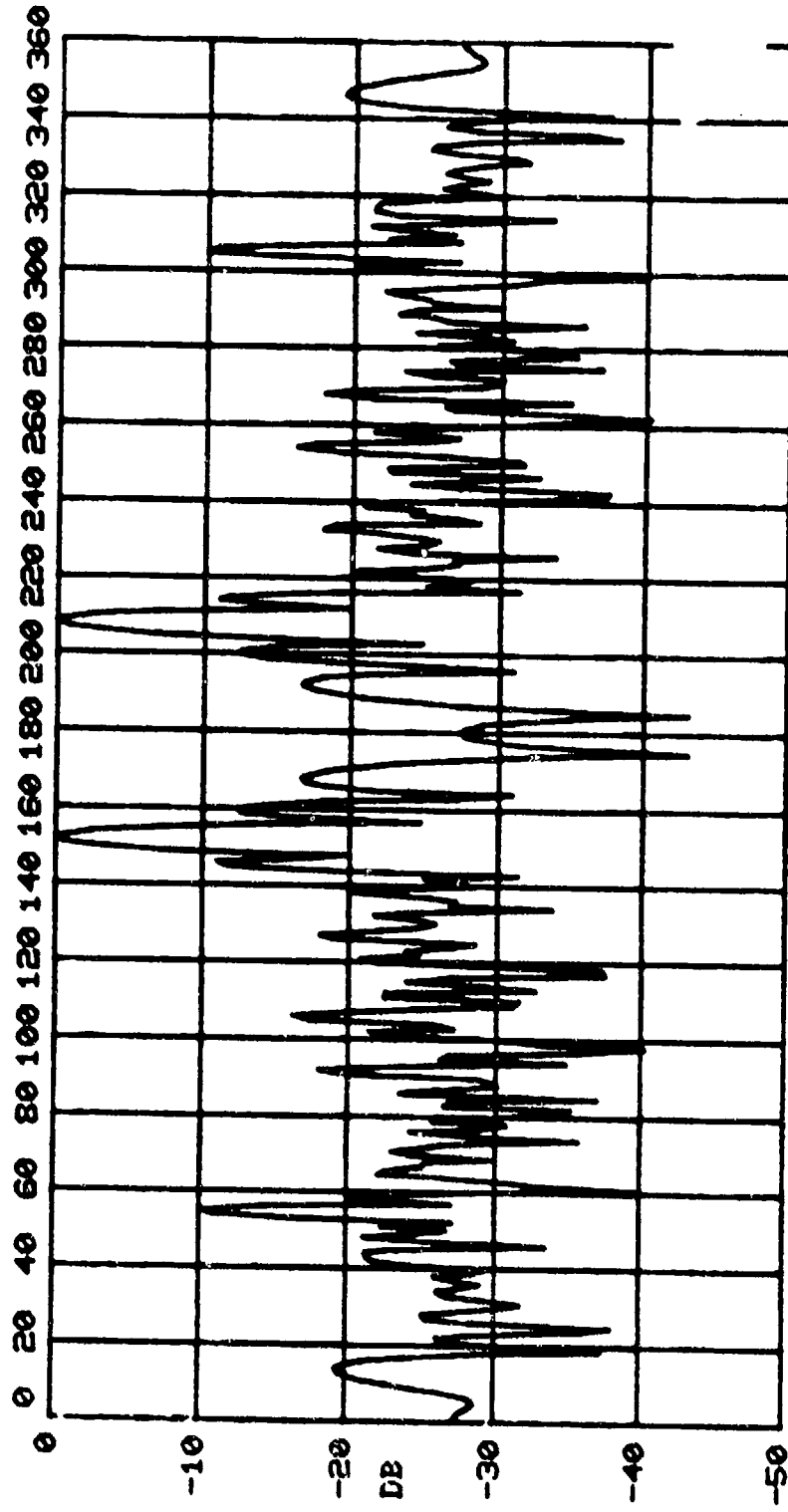


Figure G-115 Theoretical Horizontal plane Pattern for 51 Element
Array @ 290 Hz for Data Point 12, 62° Off Broadside
Steering. Beamwidth 4.14°, Azimuth Gain 15.1 dB.

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55265 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
A: SPRAY ARRAY TUNED TO 300 HZ.
8.3233 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
290.0 HZ., 32 ELEMENTS, -0.85 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.50 DEG. 3 DB BEAM, 13.14 DB AZ. GAIN, MAX. AT 209.0 DEG. HORIZ.

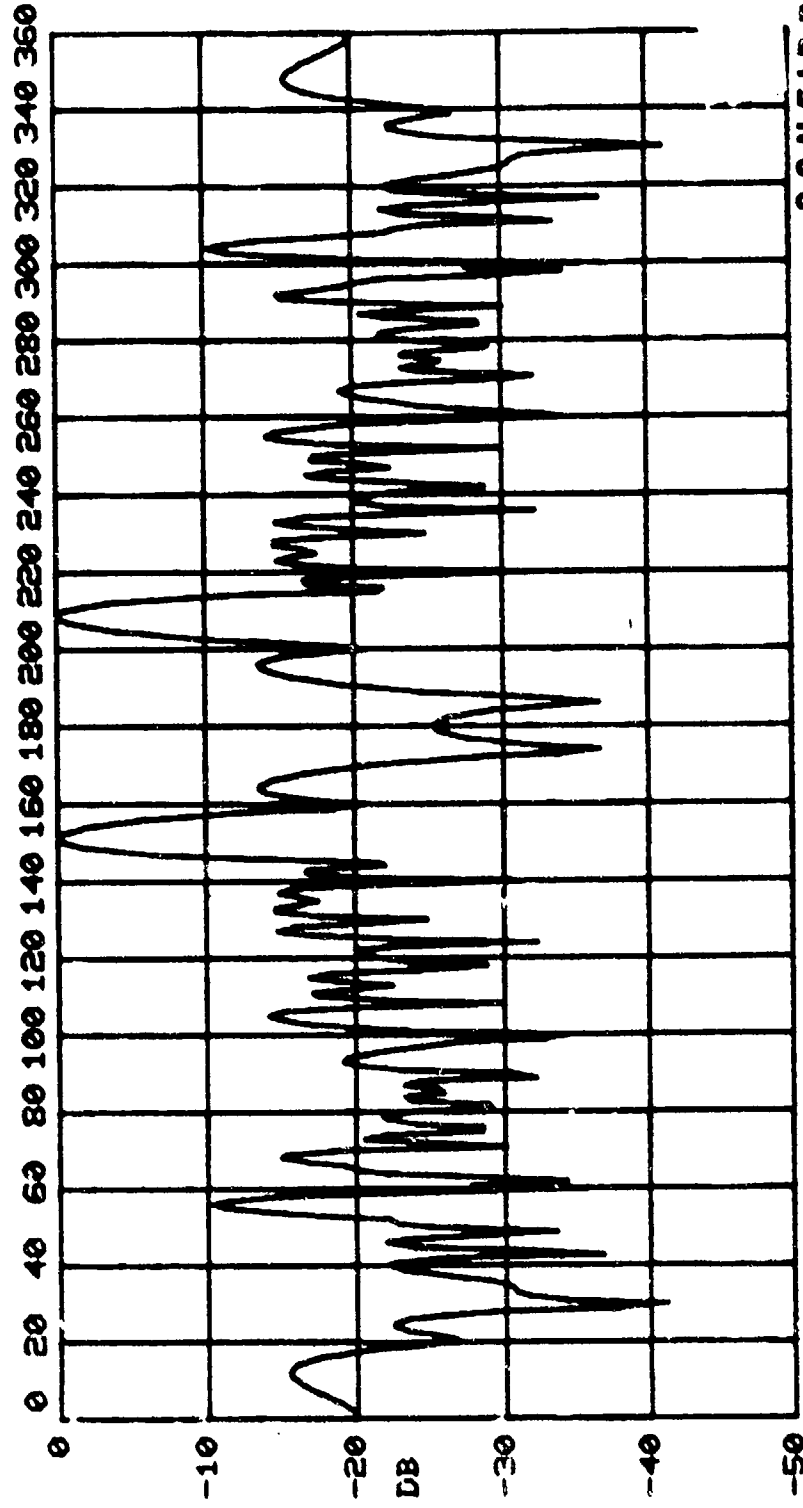


Figure B-116 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 290 Hz for Data Point 12, 6.5 Off Broadside
Steering. Beamwidth 6.50°, Azimuth Gain 13.1 dB.

CONFIDENTIAL

CONFIDENTIAL

55262 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
A: SPRAY ARRAY TUNED TO 300 HZ.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
290.0 HZ., 16 ELEMENTS, -0.76 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
14.38 DEG. 3 DB BEAM, 9.80 DB AZ. GAIN, MAX. AT 152.0 DEG. HORIZ.

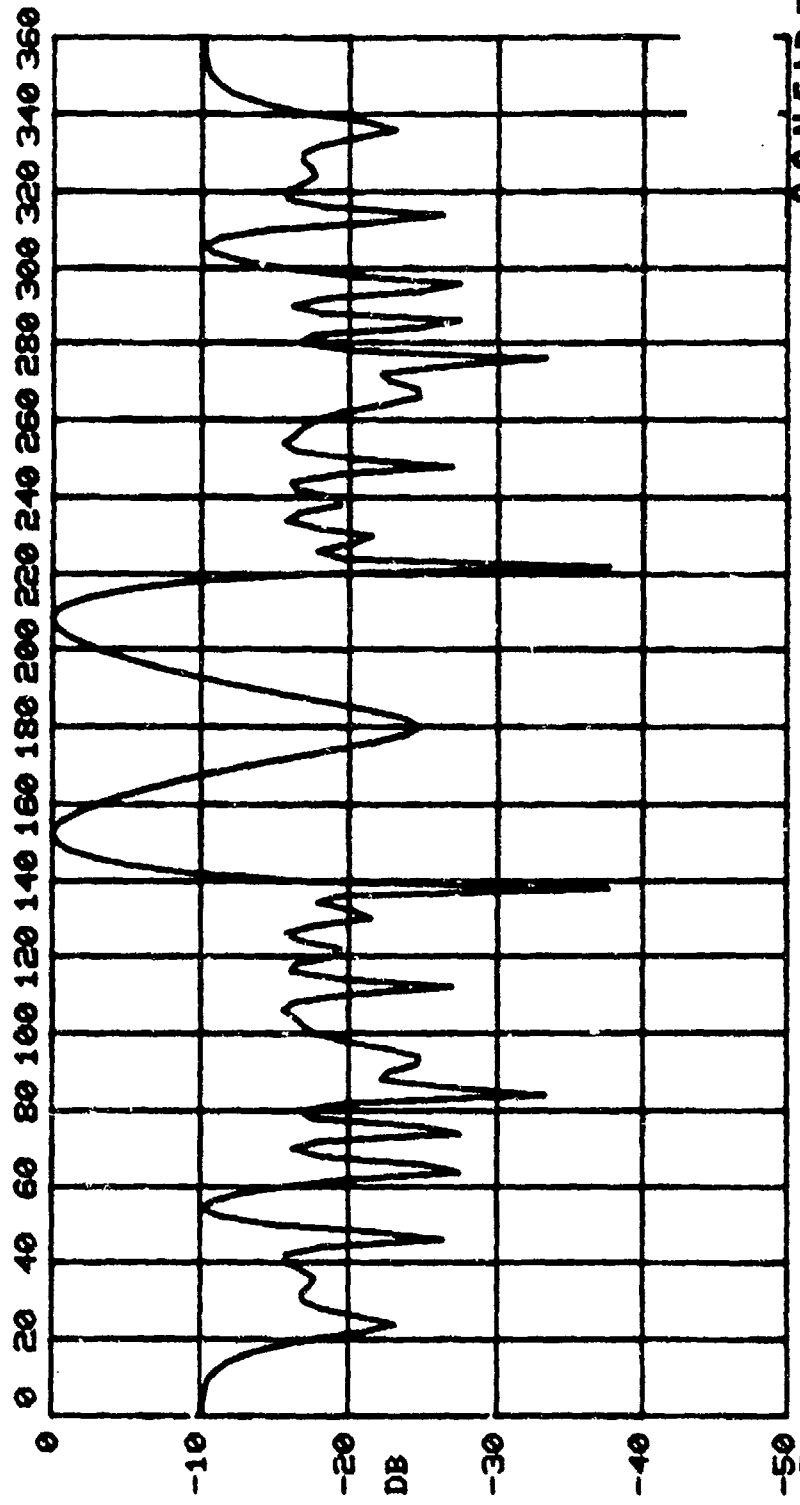


Figure B-117 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 290 Hz for Data Point 12, 41.5 Off Broadside
Steering. Beamwidth 14.38°, Azimuth Gain 9.8 dB.

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S5267 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
A: SPPAY ARRAY TUNED TO 300 HZ.
2.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
140.0 HZ., 51 ELEMENTS, -0.24 DB MAX., AC:S2581,SJ:S2581,WT:
90.0 DEG. VERT. RESP., 149.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
8.05 DEG. 3 DB BEAM, 12.62 DB AZ. GAIN, MAX. AT 150.0 DEG. HORIZ.

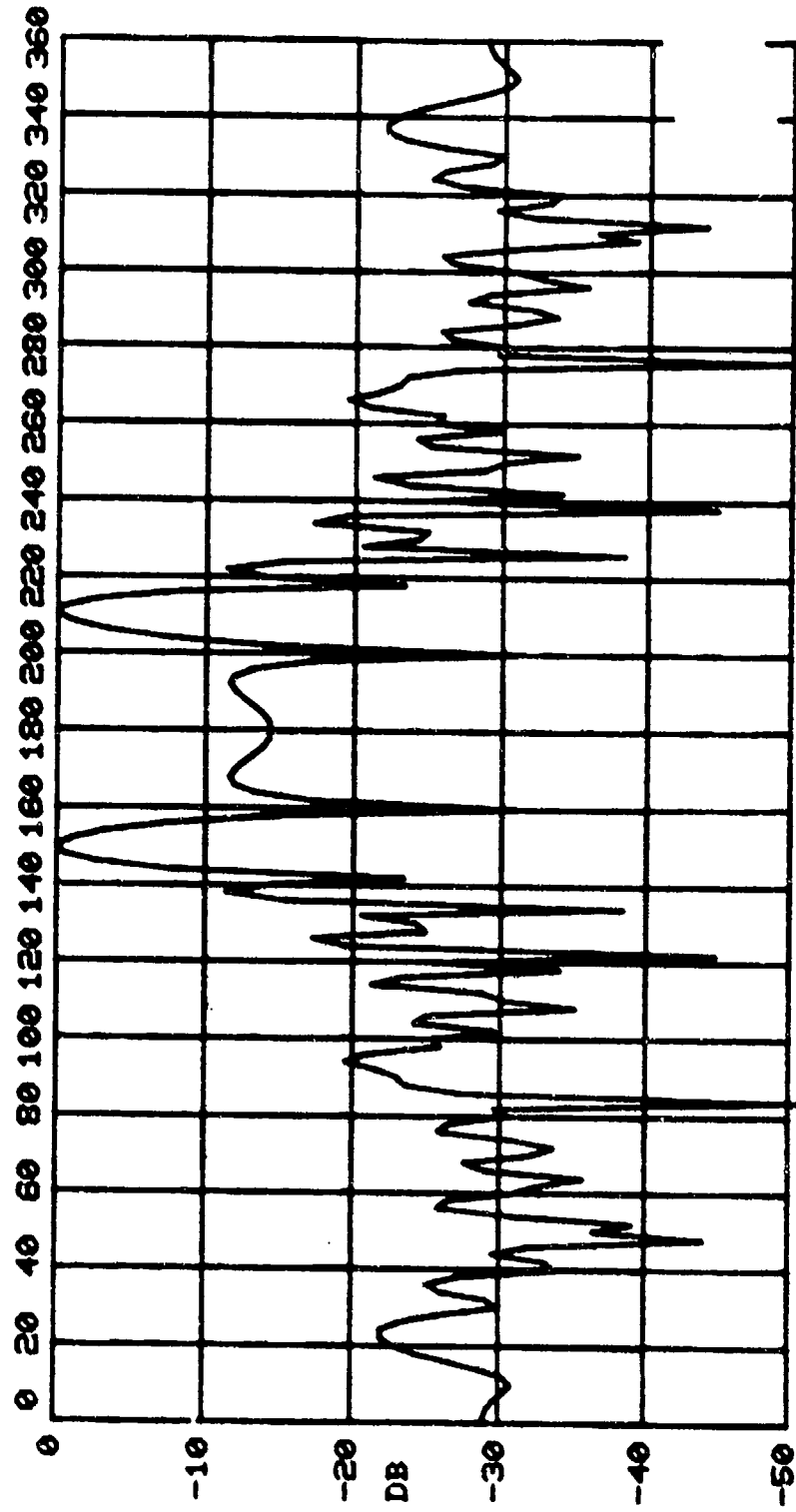


Figure B-118 Theoretical Horizontal Plane Pattern for 5/Element
Array @ 140 Hz for Data Point 12, 51.5 Off Broadside
Steering. Beamwidth 8.05°, Azimuth Gain 12.6 dB.

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S5264 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 QNTLBP 3.1
A: SPRAY ARRAY TUNED TO 300 HZ.
8.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
140.0 HZ., 32 ELEMENTS, -0.20 DB MAX., AC:S2581, SU:S2581, UT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
13.89 DEG. 3 DB BEAM, 10.61 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.

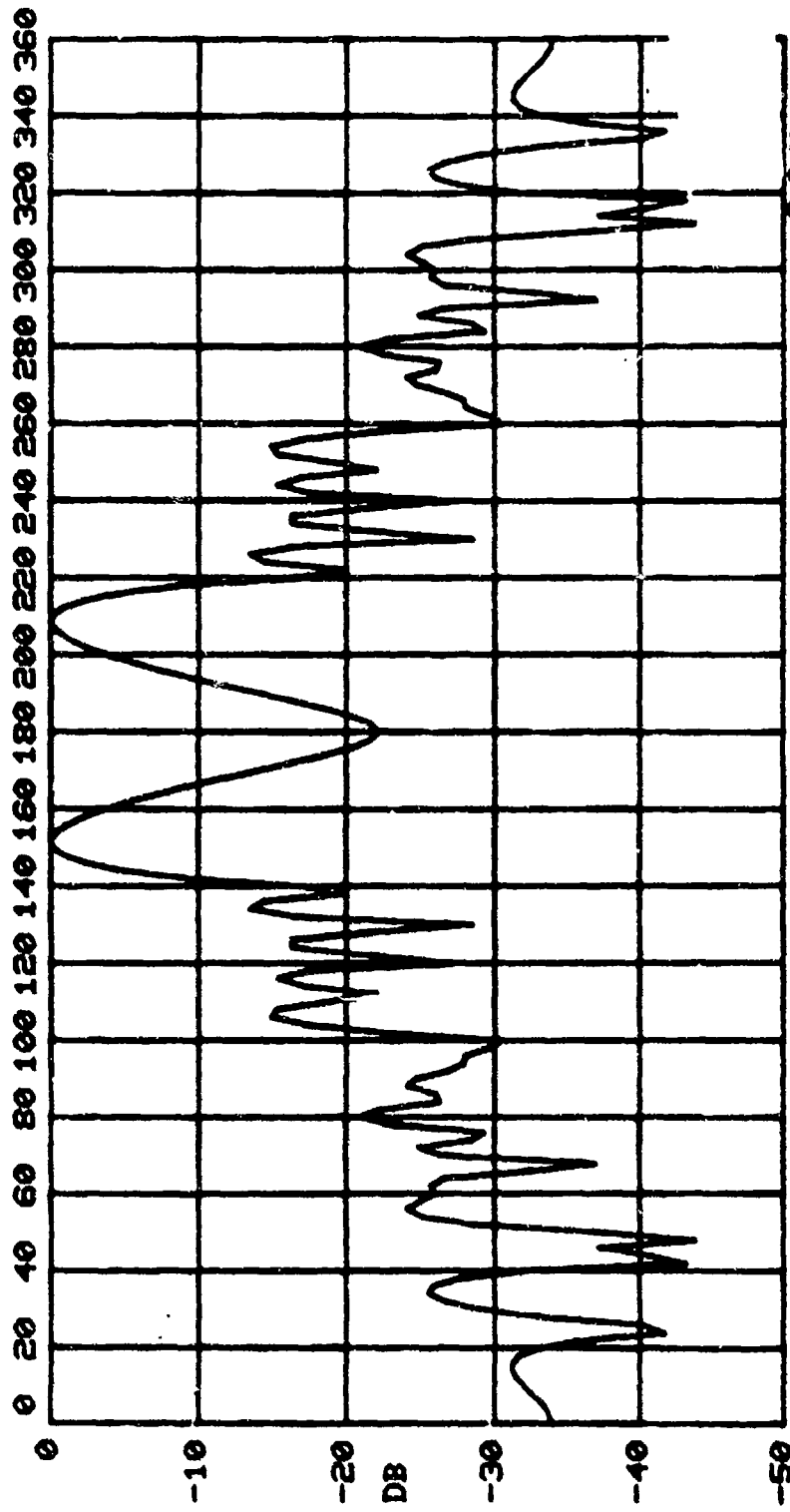


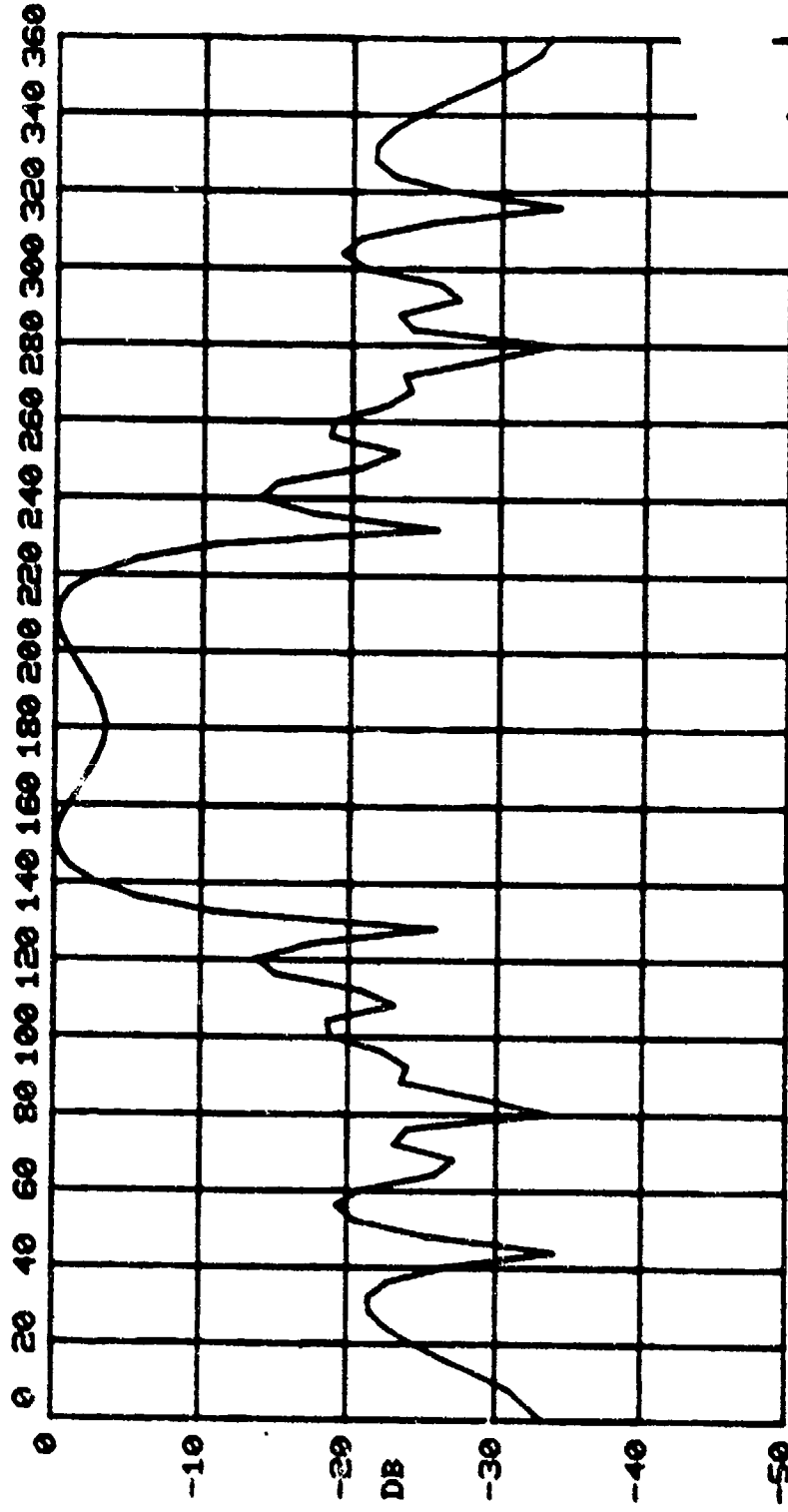
Figure B-114 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 12, 6/5 Off Broadside Steering. Beamwidth 13.89°, Azimuth Gain 10.6 dB.

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SE261 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 QNTLBP 3.1
A: SPRAY ARRAY TUNED TO 300 HZ.
8.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
140.0 HZ., 16 ELEMENTS, -0.18 DB MAX., AC:S2581, SU:S2581, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
34.91 DEG. 3 DB BEAM, 7.36 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.



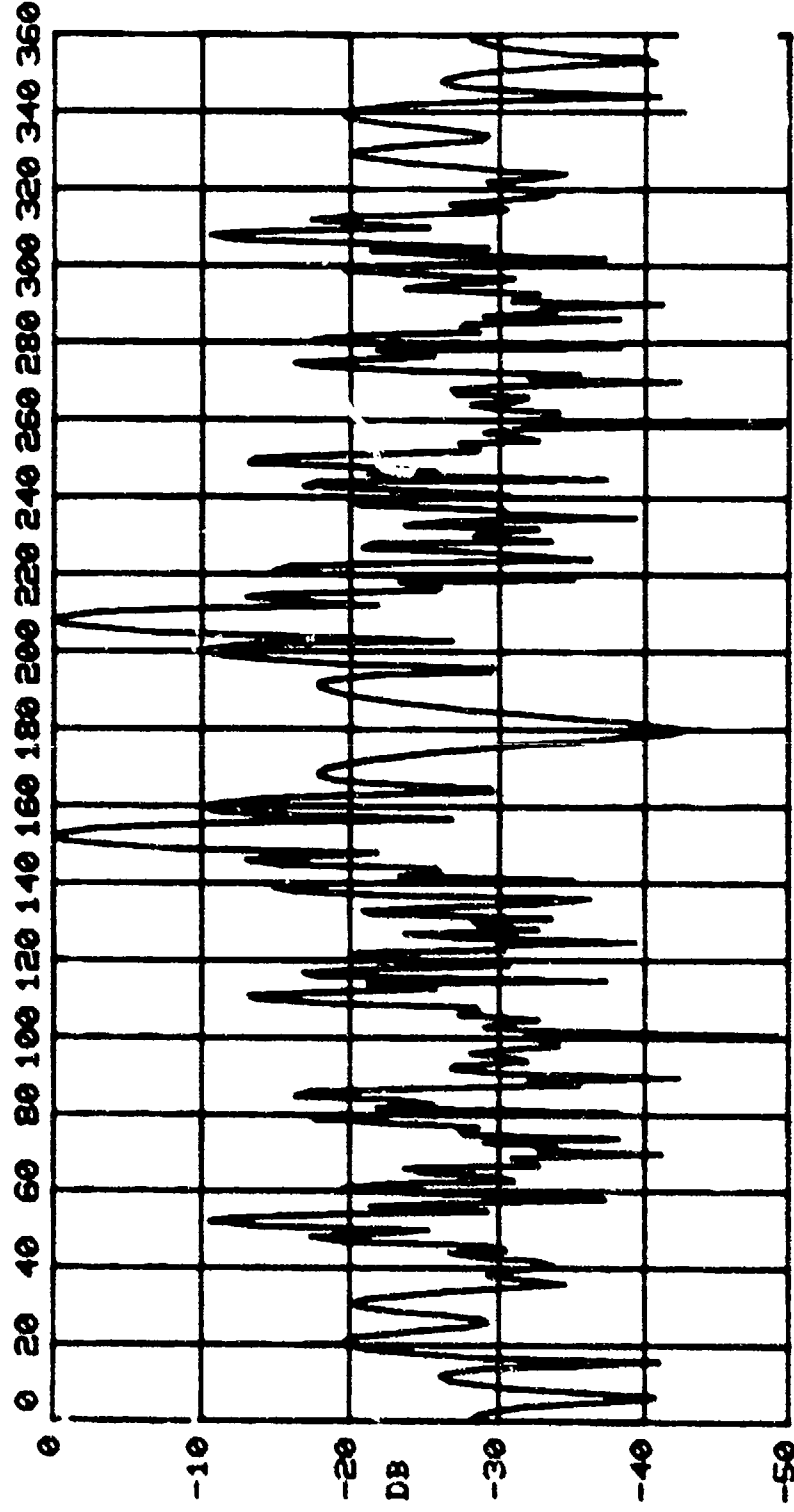
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Figure B-120 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 140 Hz for Data Point 12, 61.5 Off Broadside
Steering. Beamwidth 34.91°, Azimuth Gain 7.3 dB.

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55269 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 27-May-78 ONTLBP 3.1
A: SPEAR ARRAY TUNED TO 300 HZ.
3.3233 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
295.0 HZ., 51 ELEMENTS, -0.89 DB MAX., AC:92581, SU:92581, UT:
90.0 DEG. VERT. RESP., 152.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.06 DEG. 3 DB BEAM, 15.12 DB AZ. GAIN, MAX. AT 152.0 DEG. HORIZ.



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Figure 3-121 Theoretical Horizontal Plane Pattern for 5/Element
Array @ 295 Hz for Data Point 12, 62 Off Broadside
Steering. Beamwidth 4.06°, Azimuth Gain 15.1 dB.

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SE266 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
 "1: SPRAY ARRAY TUNED TO 300 HZ.
 2.3333 FT. UNIFORM SPACING.
 S: SAME

DATA POINT 12
 1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
 295.0 HZ., 32 ELEMENTS, -0.90 DB MAX., AC:92581, SU:92581, WT:
 90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 6.47 DEG. 3 DB BEAM, 13.07 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.

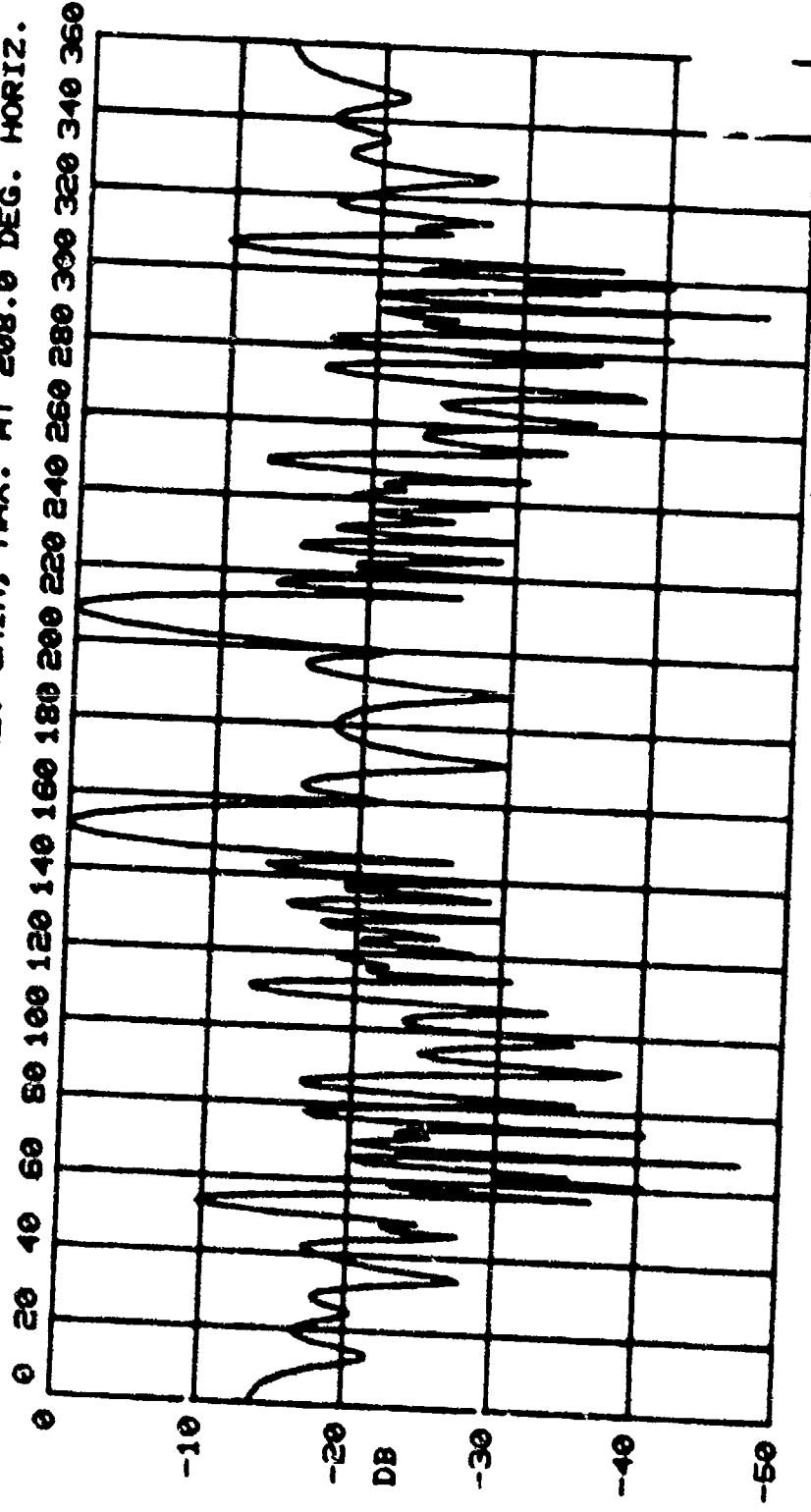


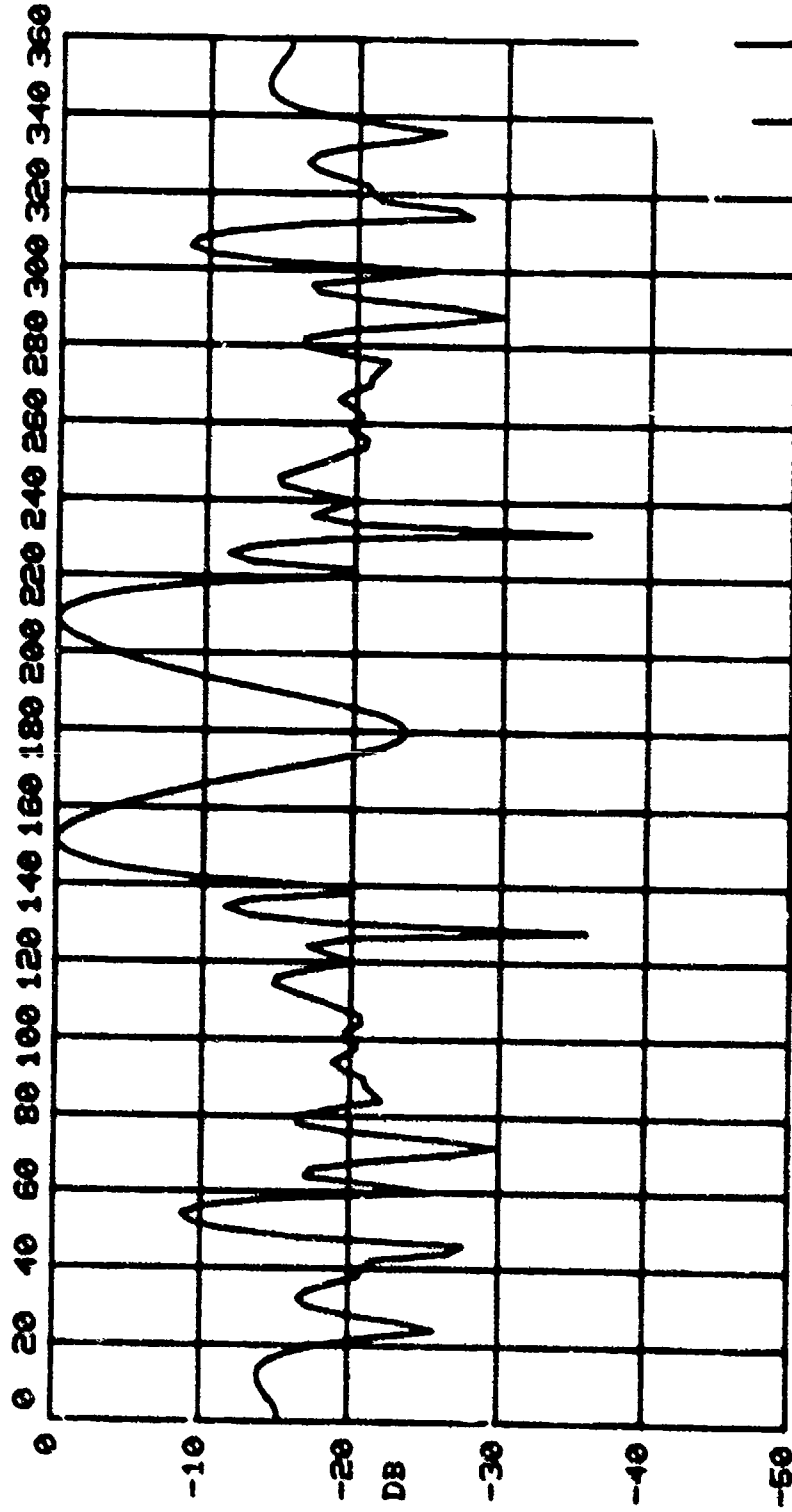
Figure B-72 Theoretical Horizontal Plane Pattern for 32 Element
 Array at 295 Hz for Data Point 12, 645 Off Broadside
 Steering. Beamwidth 6.47°, Azimuth Gain 13.0 dB.

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SS263 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
A: SPPHY ARRAY TUNED TO 300 HZ.
8.3233 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
295.0 HZ., 16 ELEMENTS, -0.79 DB MAX., AC:S2581, SU:S2581, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
13.79 DEG. 3 DB BEAM, 10.06 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.



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Figure B-123 Theoretical Horizontal Plane Pattern for 16 Element
Array 1295 Hz for Data Point 12, 61.5 Off Broadside
Steering. Beamwidth 13.79°, Azimuth Gain 10.0 dB.

UNCLASSIFIED

APPENDIX C MEASURED BEAMWIDTH DATA (U)

UNCLASSIFIED

460103

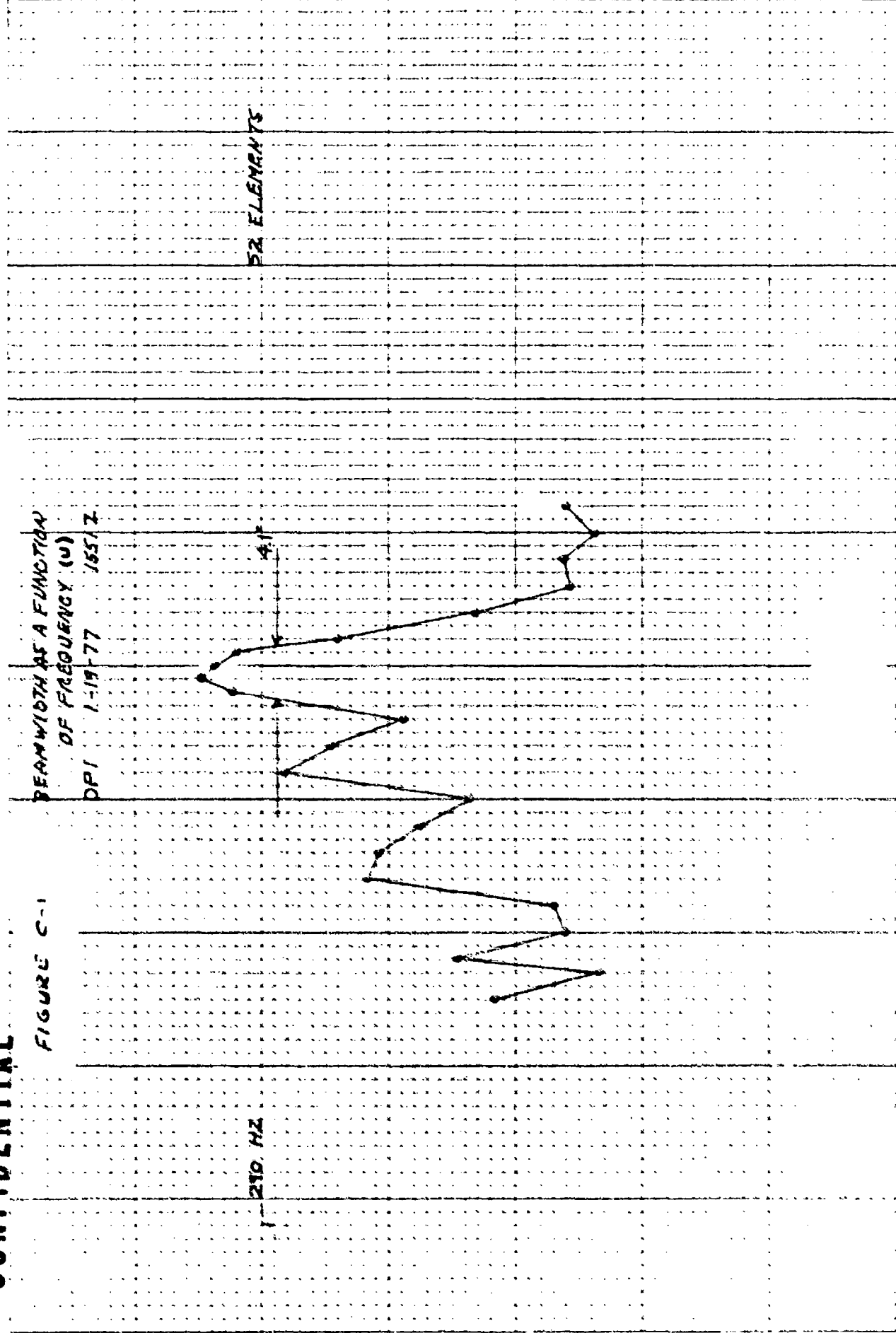
FIG. 2. BEAMWIDTH AS A FUNCTION OF FREQUENCY (U)

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FIGURE C-1

BEAMWIDTH AS A FUNCTION OF FREQUENCY (U)

DPI 1-19-77 15512



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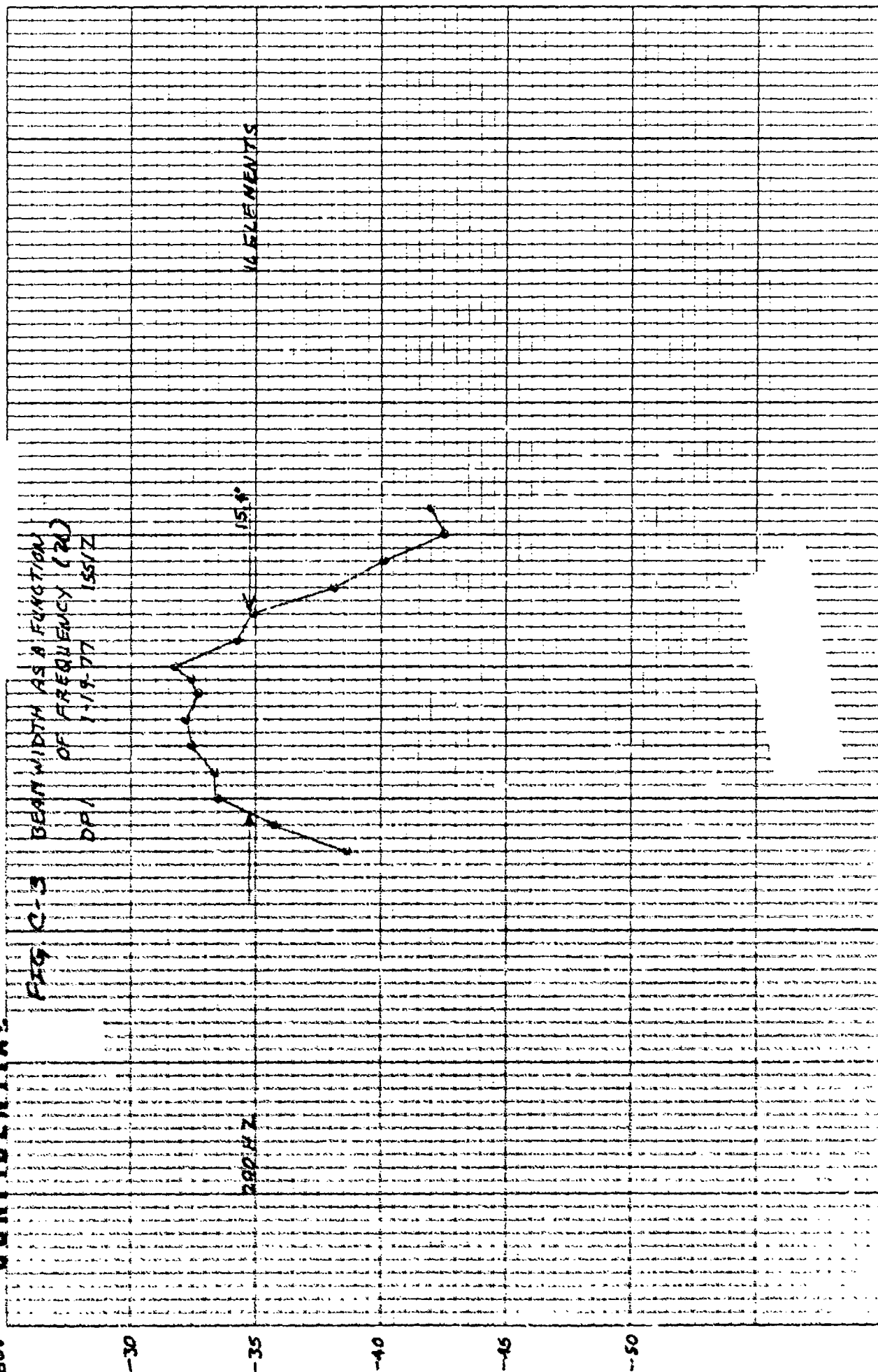
DEGREES OFF BROADSIDE

46 D/US

FIG 2 10 A IN TO THE HORIZONTAL AXIS

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DEGREES OFF BROAD SIDE

46 0703

NO. 2 IS NOT A TRUE COPY OF THE ORIGINAL
REPRODUCED FROM THE ORIGINAL

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FIG. C-4
BEAMWIDTH AS A FUNCTION
OF FREQUENCY (24)
DPI 1-19-77

BEAMWIDTH



2951 Hz

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DEGREES OFF BROADSIDE

152

2

2

2

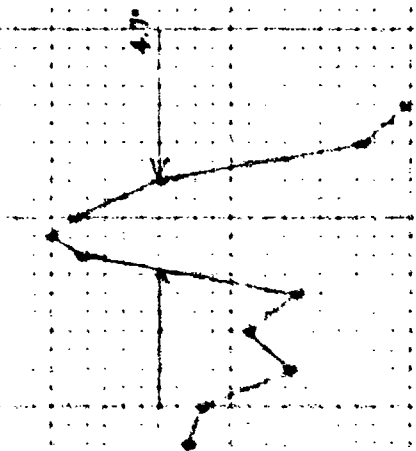
50 -60 -70
DEGREES OFF BROADSIDE

42

46 0103

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FIG. C-7 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (2L)
DPA 1-17-77 1600Z



200 HZ

50 ELEMENTS

-40

-50 -60 -70
DEGREES OFF BROADSIDE

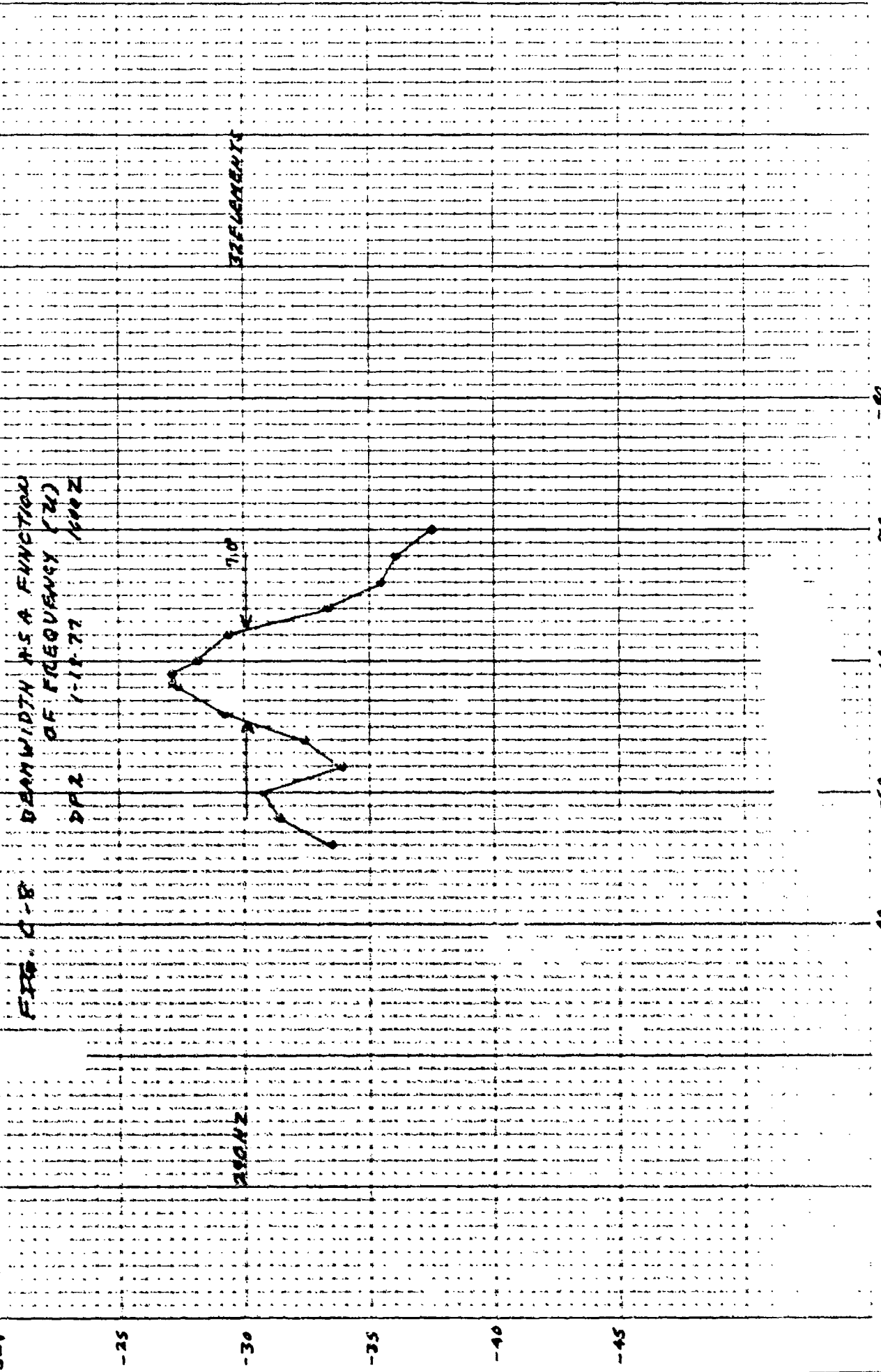
-80

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REF ID: A60703

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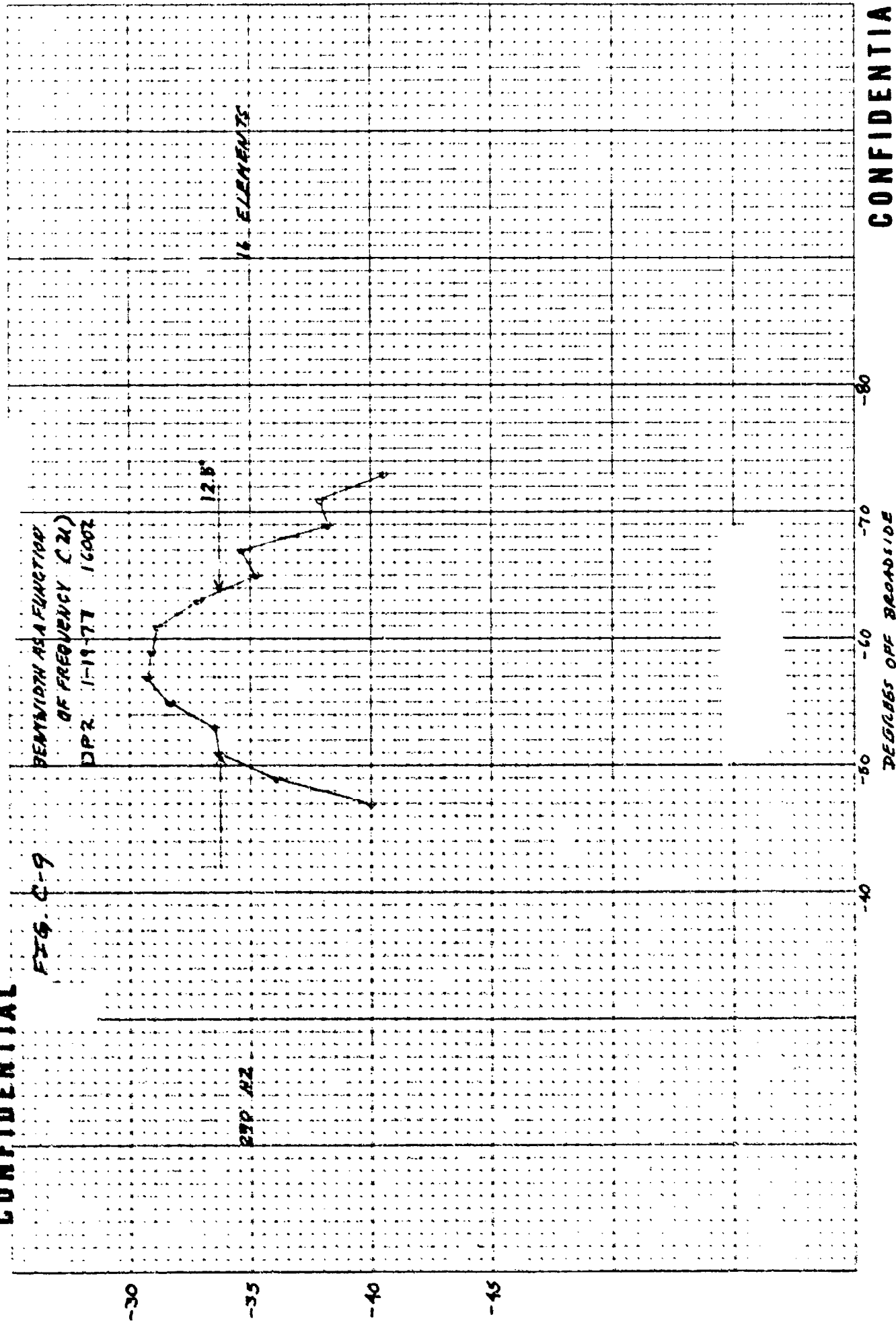
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FIG. C-9

BANDWIDTH AS A FUNCTION
OF FREQUENCY (24)
DPR 1-19-77 1600Z



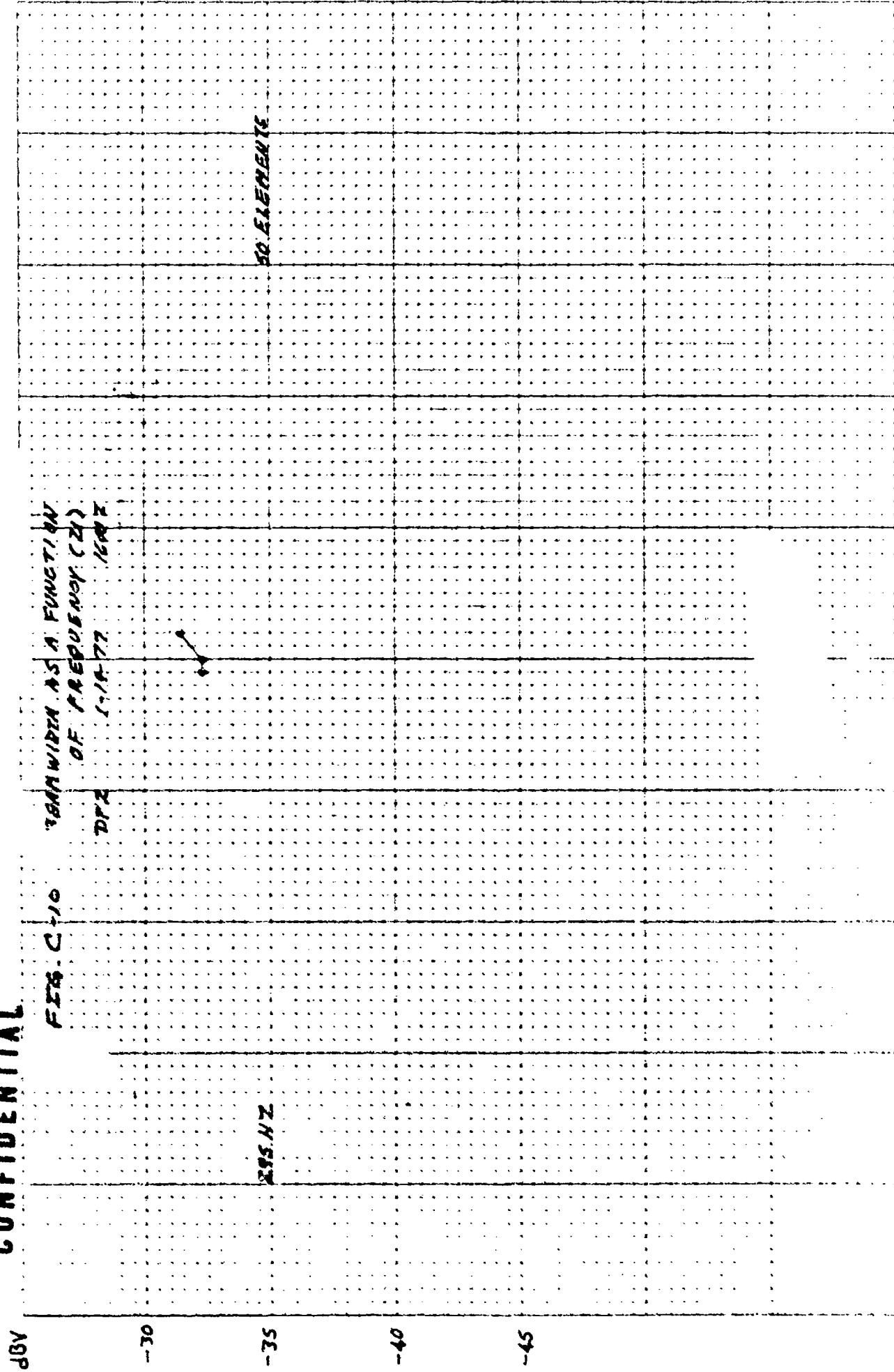
DEGREES OFF BROADSIDE

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46 0/03

REF ID: A66003

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DEGREES OFF BROADSIDE

46 0703

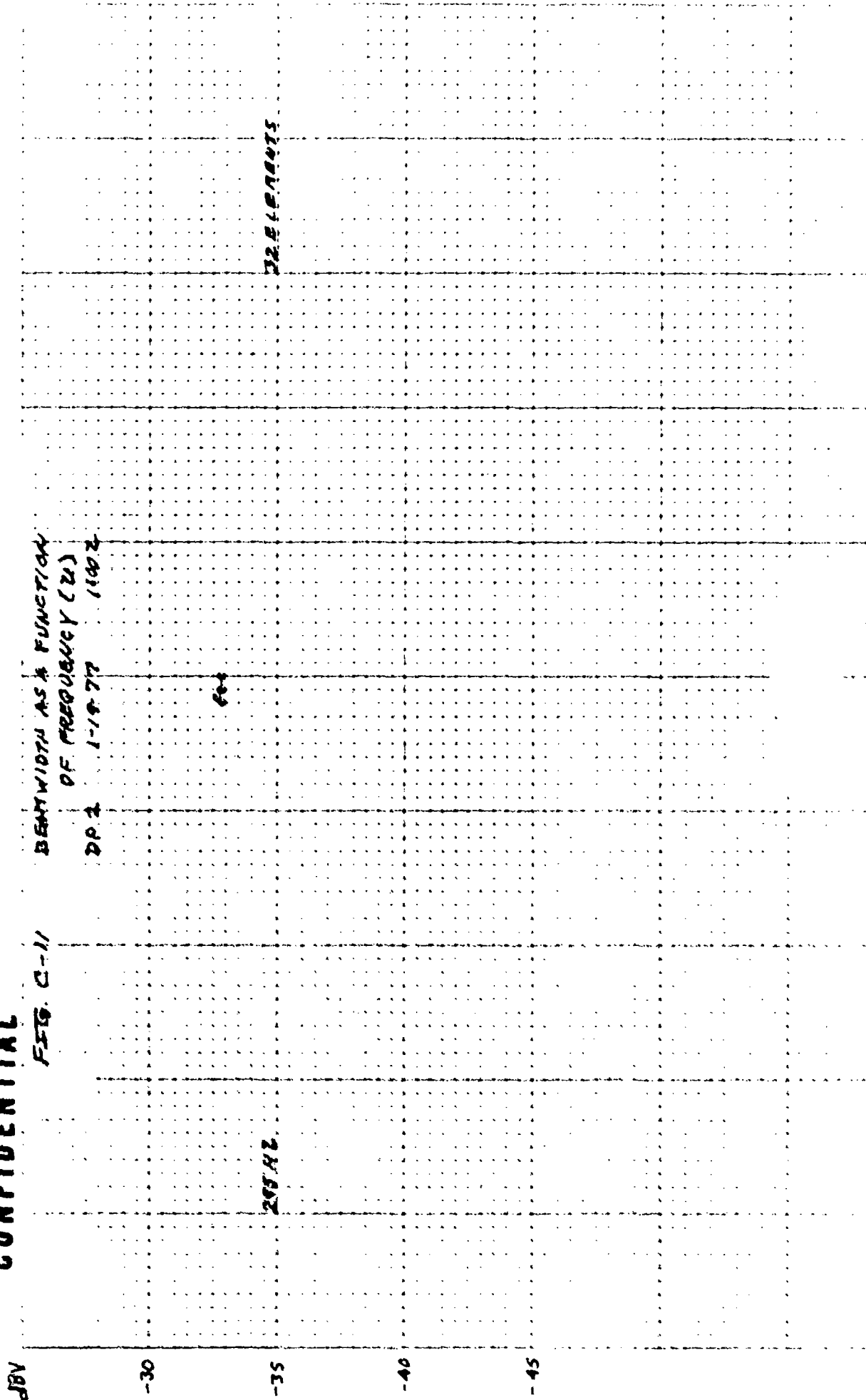
NOE 2-1-77

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FIG. C-11

BANDWIDTH AS A FUNCTION
OF FREQUENCY (Hz)

DP 2 1-19-77 11002



-50 -60 -70
DEGREES OFF BROADSIDE

-80

-40

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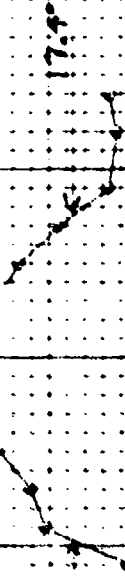
FIG. C-12

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FIG. C-12

SEMINIWIDTH AS A FUNCTION
OF FREQUENCY (Hz)

DF2, 1-19-92, 1600Z



255 HZ

16. ELP M0015

-80

-70

-60

-50

-40

-30

-20

-10

0

10

20

30

40

50

60

70

80

90

100

110

120

130

140

150

160

170

180

190

200

210

220

230

240

250

260

270

280

290

300

310

320

330

340

350

360

370

380

390

400

410

420

430

440

450

460

470

480

490

500

510

520

530

540

550

560

570

580

590

600

610

620

630

640

650

660

670

680

690

700

710

720

730

740

750

760

770

780

790

800

810

820

830

840

850

860

870

880

890

900

910

920

930

940

950

960

970

980

990

1000

1010

1020

1030

1040

1050

1060

1070

1080

1090

1100

1110

1120

1130

1140

1150

1160

1170

1180

1190

1200

1210

1220

1230

1240

1250

1260

1270

1280

1290

1300

1310

1320

1330

1340

1350

1360

1370

1380

1390

1400

1410

1420

1430

1440

1450

1460

1470

1480

1490

1500

1510

1520

1530

1540

1550

1560

1570

1580

1590

1600

1610

1620

1630

1640

1650

1660

1670

1680

1690

1700

1710

1720

1730

1740

1750

1760

1770

1780

1790

1800

1810

1820

1830

1840

1850

1860

1870

1880

1890

1900

1910

1920

1930

1940

1950

1960

1970

1980

1990

2000

2010

2020

2030

2040

2050

2060

2070

2080

2090

2100

2110

2120

2130

2140

2150

2160

2170

2180

2190

2200

2210

2220

2230

2240

2250

2260

2270

2280

2290

2300

2310

2320

2330

2340

2350

2360

2370

2380

2390

2400

2410

2420

2430

2440

2450

2460

2470

2480

2490

2500

2510

2520

2530

2540

2550

2560

2570

2580

2590

2600

2610

2620

2630

2640

2650

2660

2670

2680

2690

2700

2710

2720

2730

2740

2750

2760

2770

2780

2790

2800

2810

2820

2830

2840

2850

2860

46, 1153

NOE 1153

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FREQ. C-13 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (MHz)
LPT 2.7.77 0934Z

-5

-10

-15

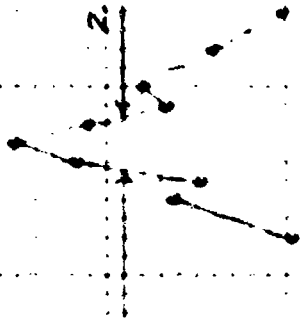
-20

-25

370 HZ

2.7

ELEMENTS



110

120

130

140

150

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-30

-10

250HZ

-15

-20

-25

-30

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FIG. C-14 DEVIATION AS A FUNCTION
OF FREQUENCY (20)
DP 2-2-77 0034Z

2.9°

22 ELEMENTS

110

120

130

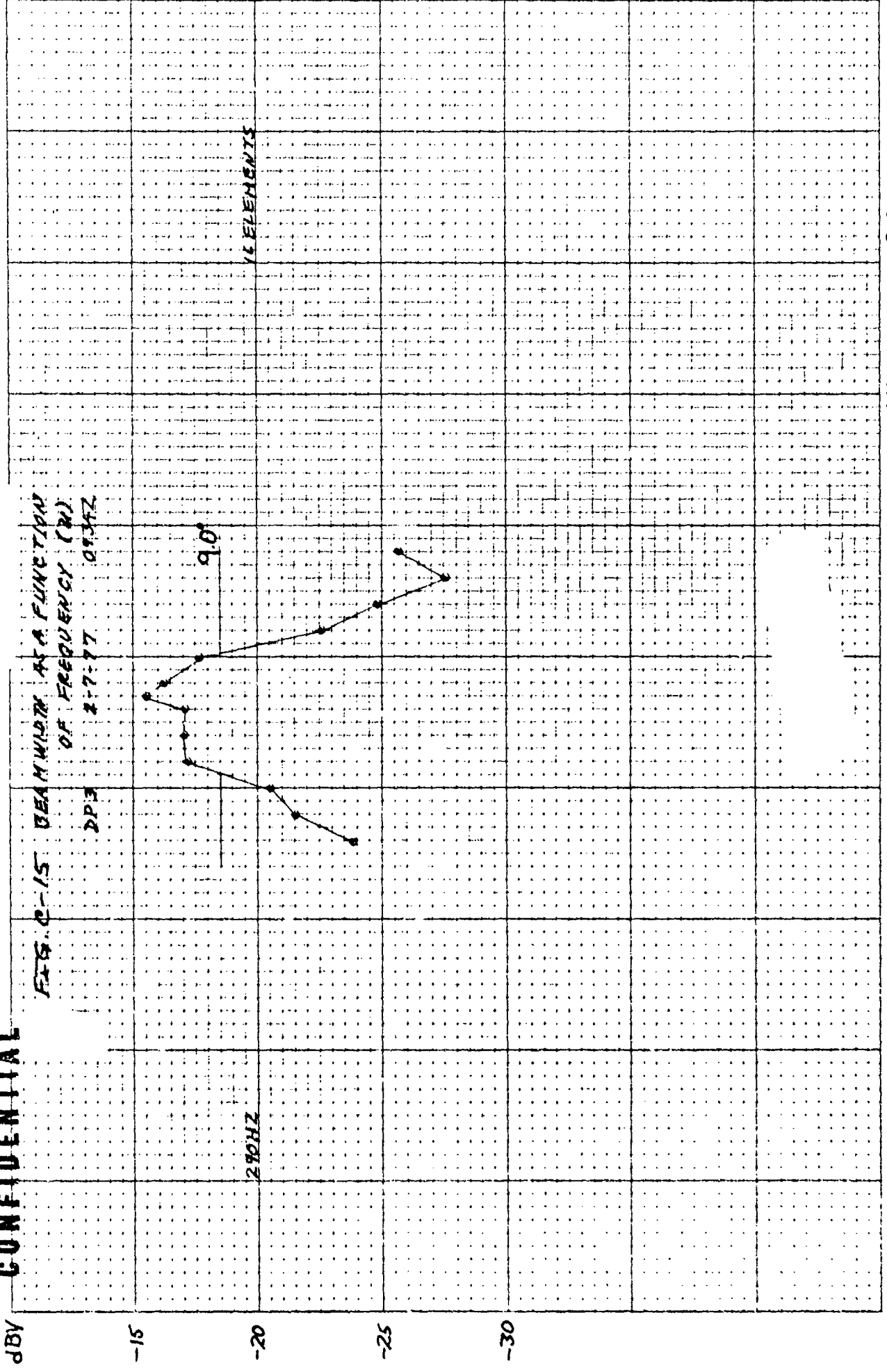
140

150

DEGREES OFF BROADSIDE

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466105

189

AAA

9-2-77

21560

42

148-851

STANDARD

014

+26

+30

04+

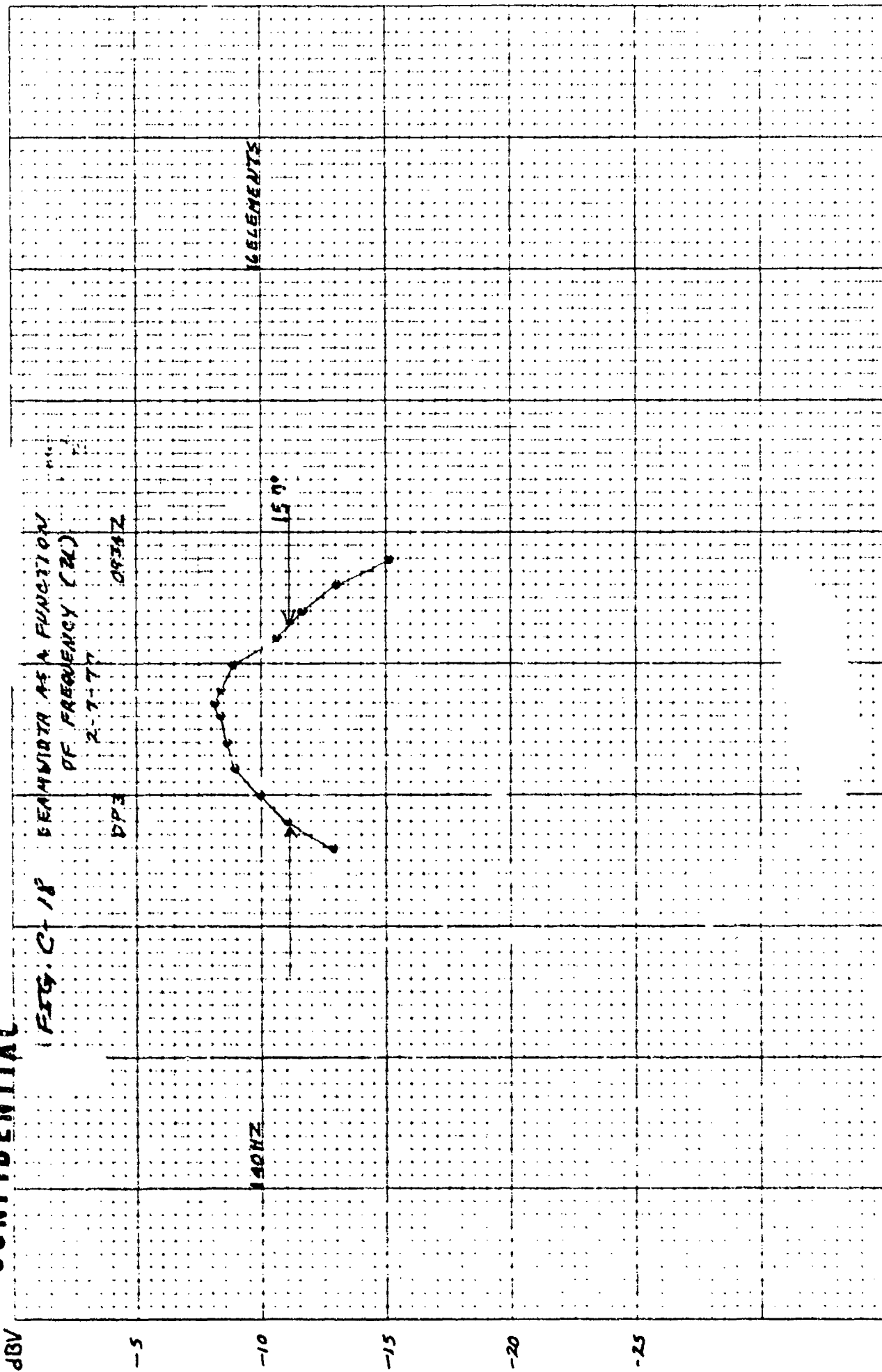
50

+20 +30 +40
DEGREES OFF BROADSIDE

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FIG. C-18 BEAMWIDTH AS A FUNCTION OF FREQUENCY (ZL)



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DEGREES OFF BROADSIDE

+50

+40

+30

+20

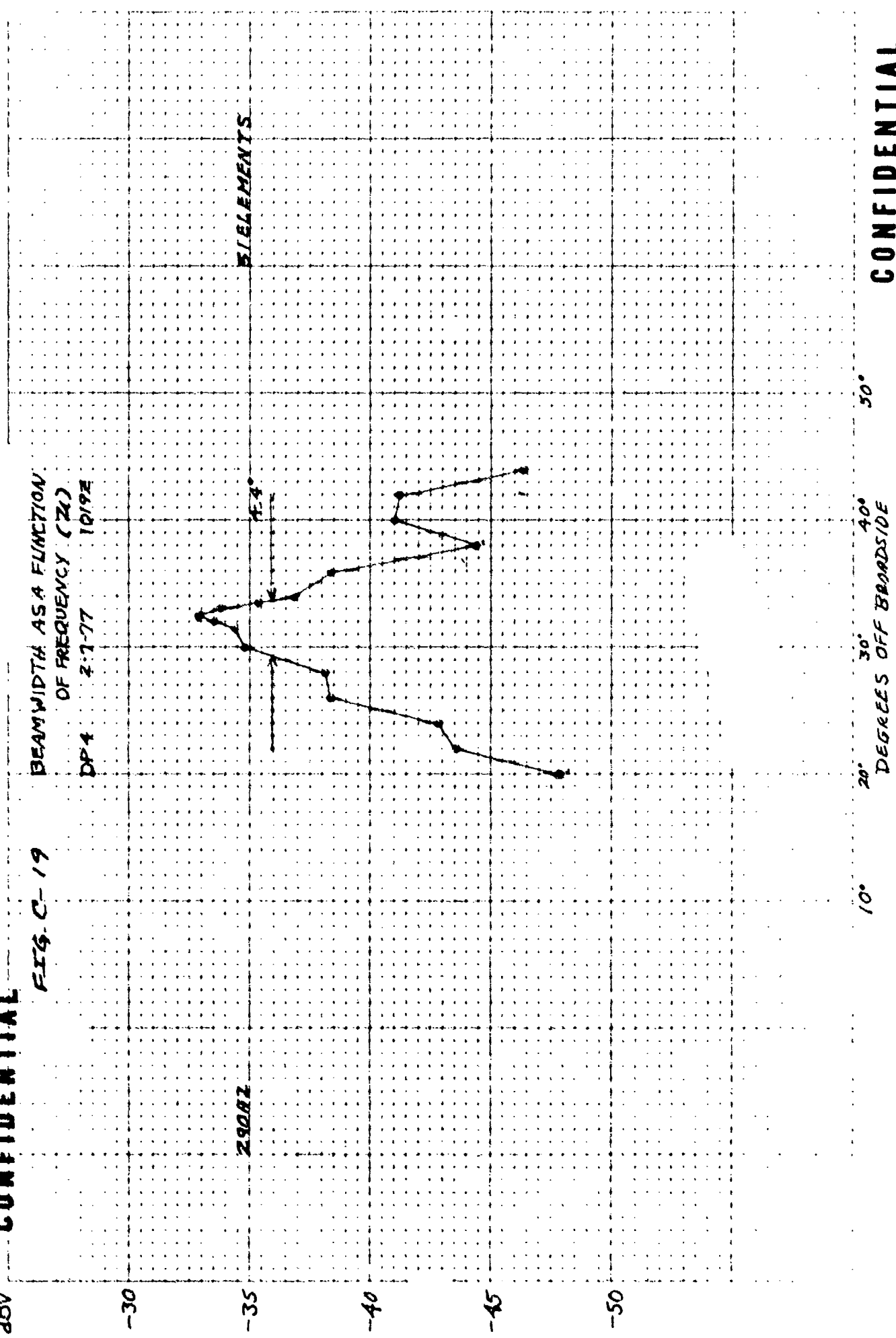
+10

REF: JPL 10-10-77

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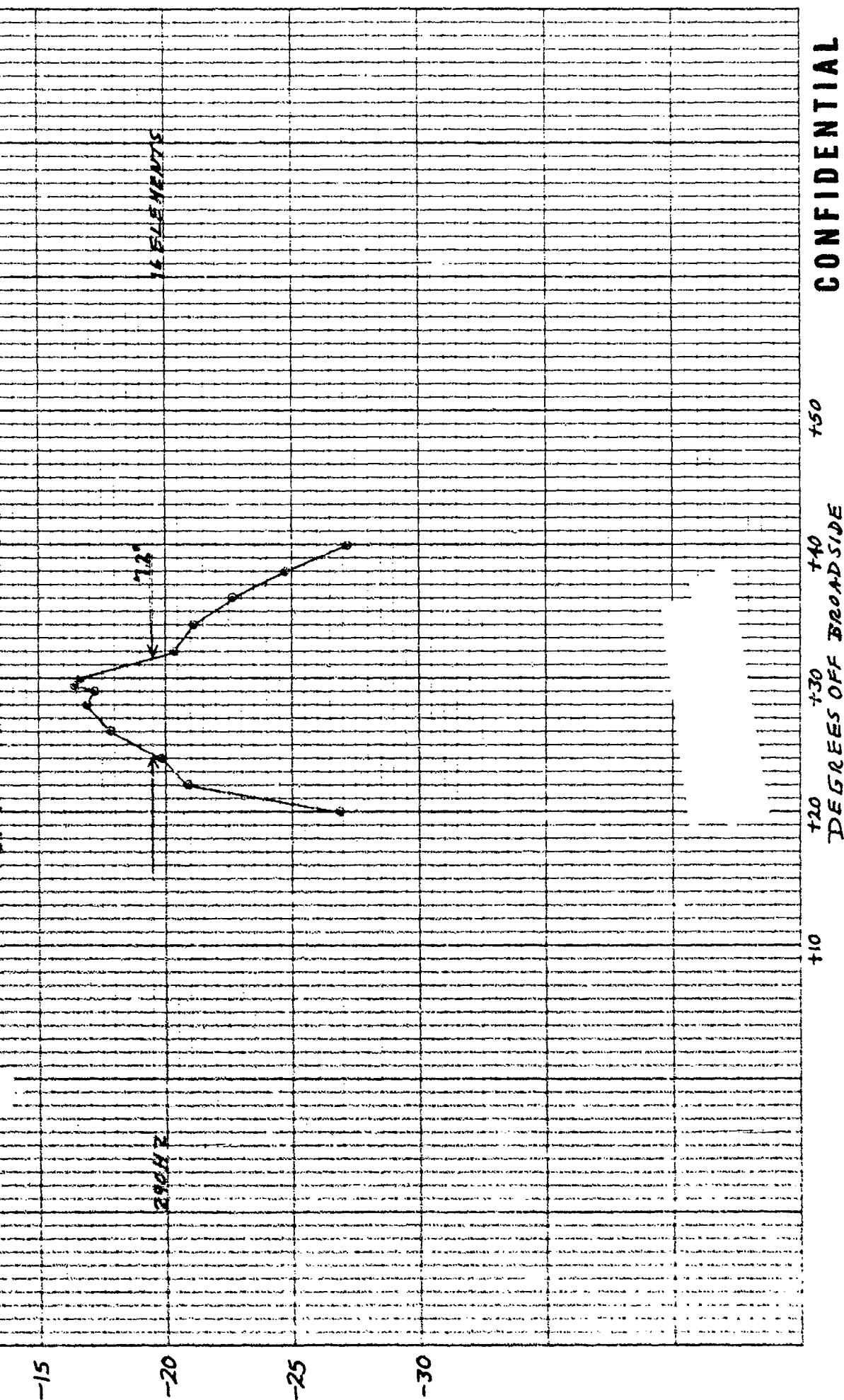
FIG. C-19
BEAMWIDTH AS A FUNCTION
OF FREQUENCY (22)
DP4 2-7-77 10/92



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FIG. 2-21
DEADWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DP # 2-7-77 10/83

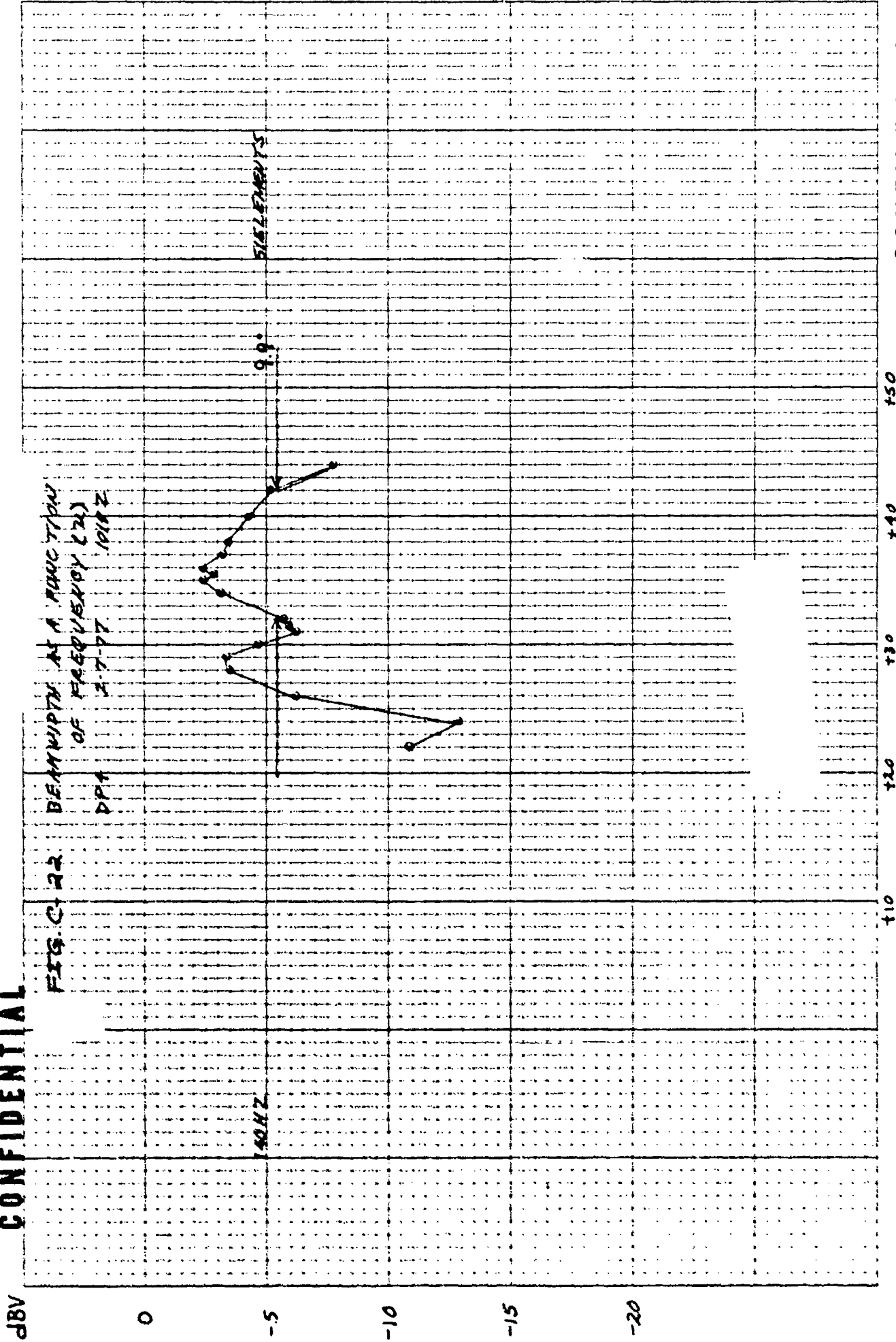


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FIG. C-22 DEPTH AS A FUNCTION OF FREQUENCY (20)

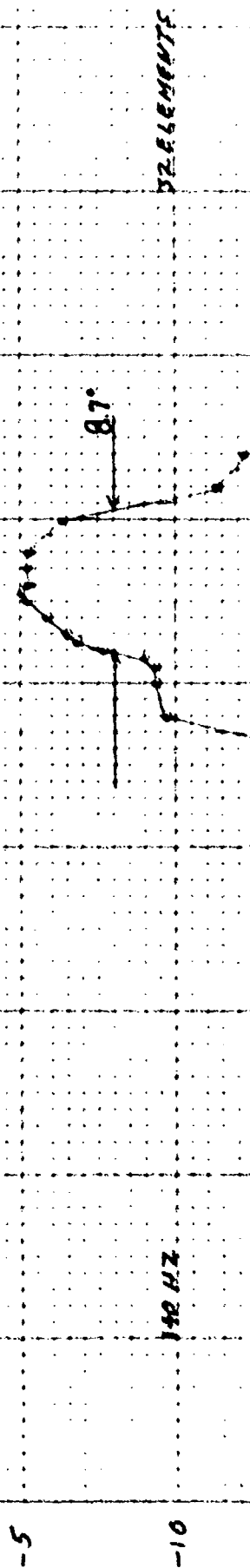
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FIG. C-23 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (20)
DP 1 8.7-17 1019Z



140 HZ

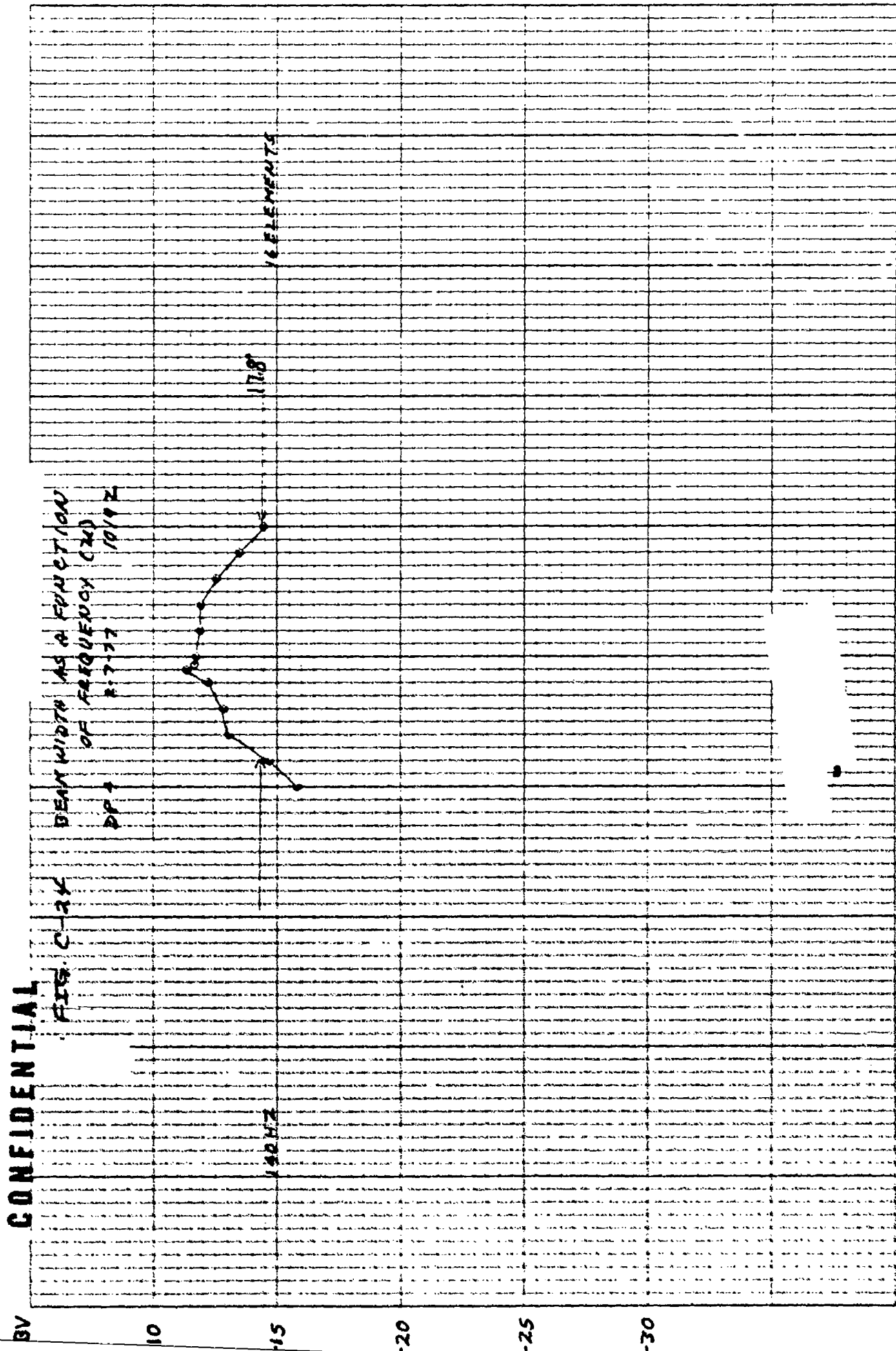
87°

DEGREES

+10 +20 +30 +40 +50
DEGREES OFF B

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DEGREES OFF BROADSIDE

46,0103

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FIG. C-25 BANDWIDTH AS A FUNCTION OF FREQUENCY (MHz)

DPS 27.77 15492

dB

-5

-10

-15

-20

-25

290 MHz

81 ELEMENTS

5.9°

+20

+30

+40

+50

+60

DEGREES OFF BROADSIDE

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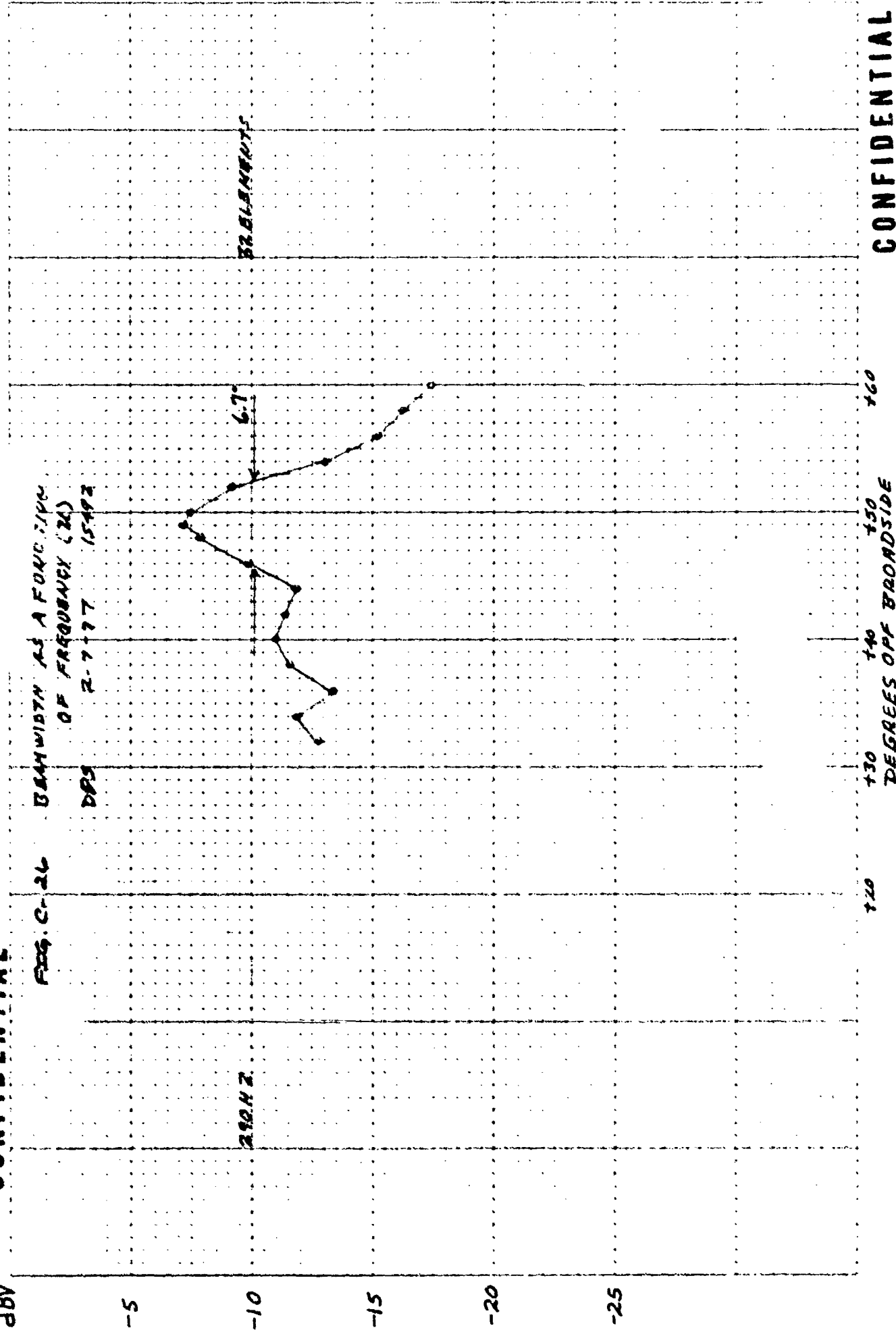
14-E 14-0000 14-0000 14-0000

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FIG. C-26 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (20)

DPS 2-7-77 15492

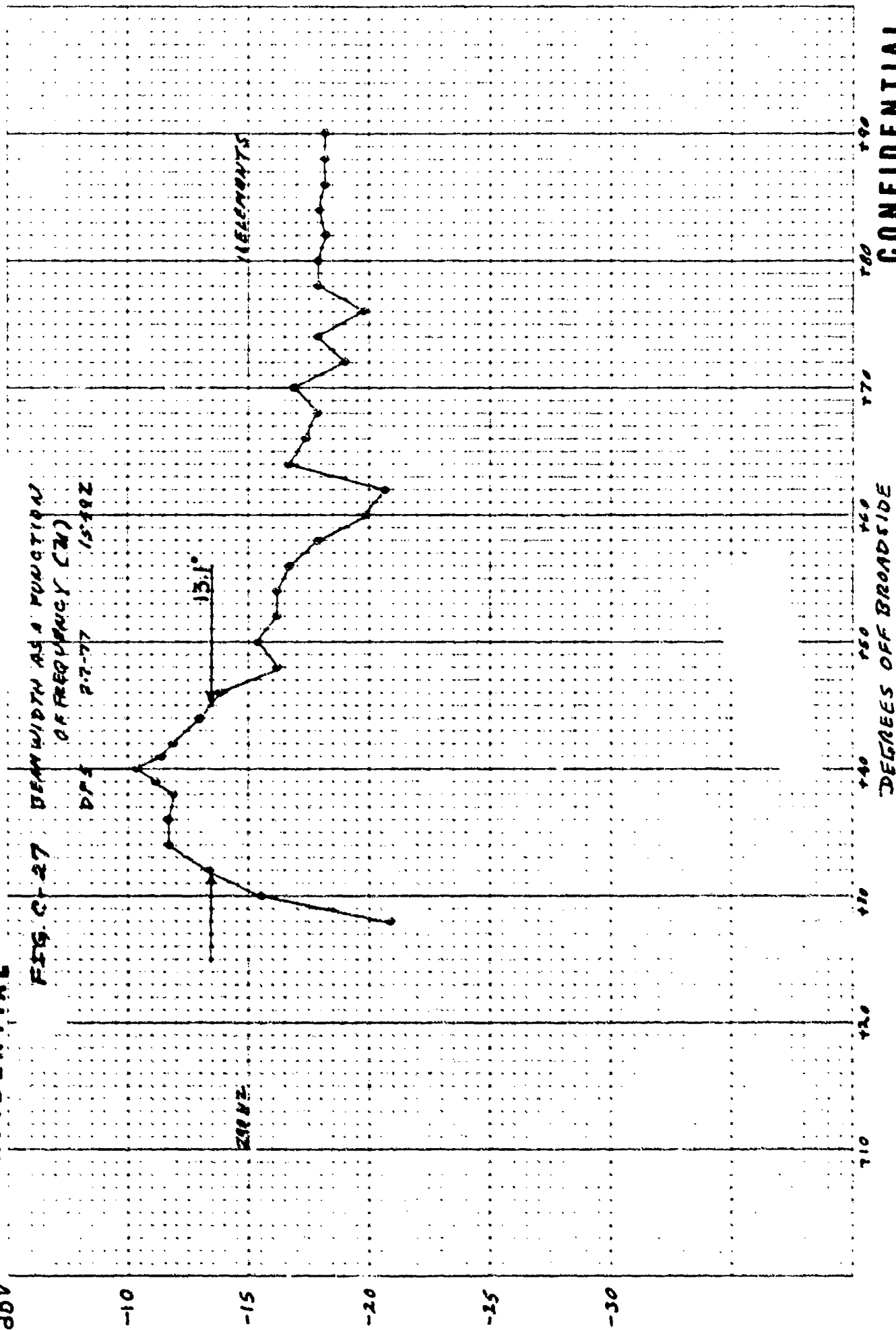


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FIG. C-27 BANDWIDTH AS A FUNCTION OF FREQUENCY (MHz)



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DEGREES OFF BROADSIDE

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FIG. C-28

BEAM WIDTH AS A FUNCTION
OF FREQUENCY (24)
DPS 2-877

7.9° 1840Z

140HZ

STATEMENTS

DEGREES OFF BROADSIDE

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FIG. C-29

BEAM WIDTH AS A FUNCTION
OF FREQUENCY (Hz)

DPS

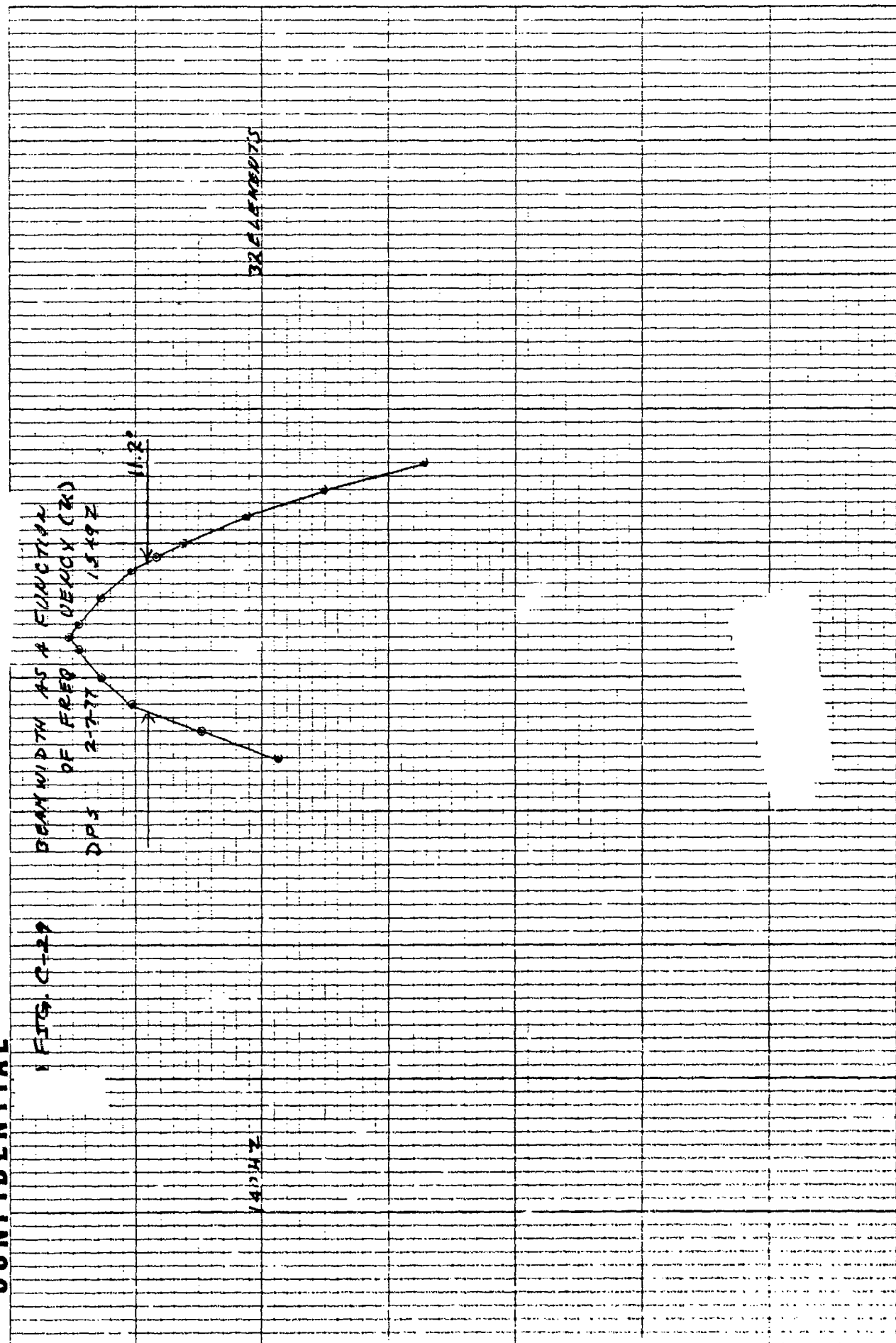
2-7-77

15-9-77

11-2

14.1 Hz

32 ELEMENTS



160

150

140

130

120

110

100

90

80

70

60

50

40

30

20

10

0

-10

-20

-30

-40

-50

-60

-70

-80

-90

-100

-110

-120

-130

-140

-150

-160

-170

-180

-190

-200

-210

-220

-230

-240

-250

-260

-270

-280

-290

-300

-310

-320

-330

-340

-350

-360

-370

-380

-390

-400

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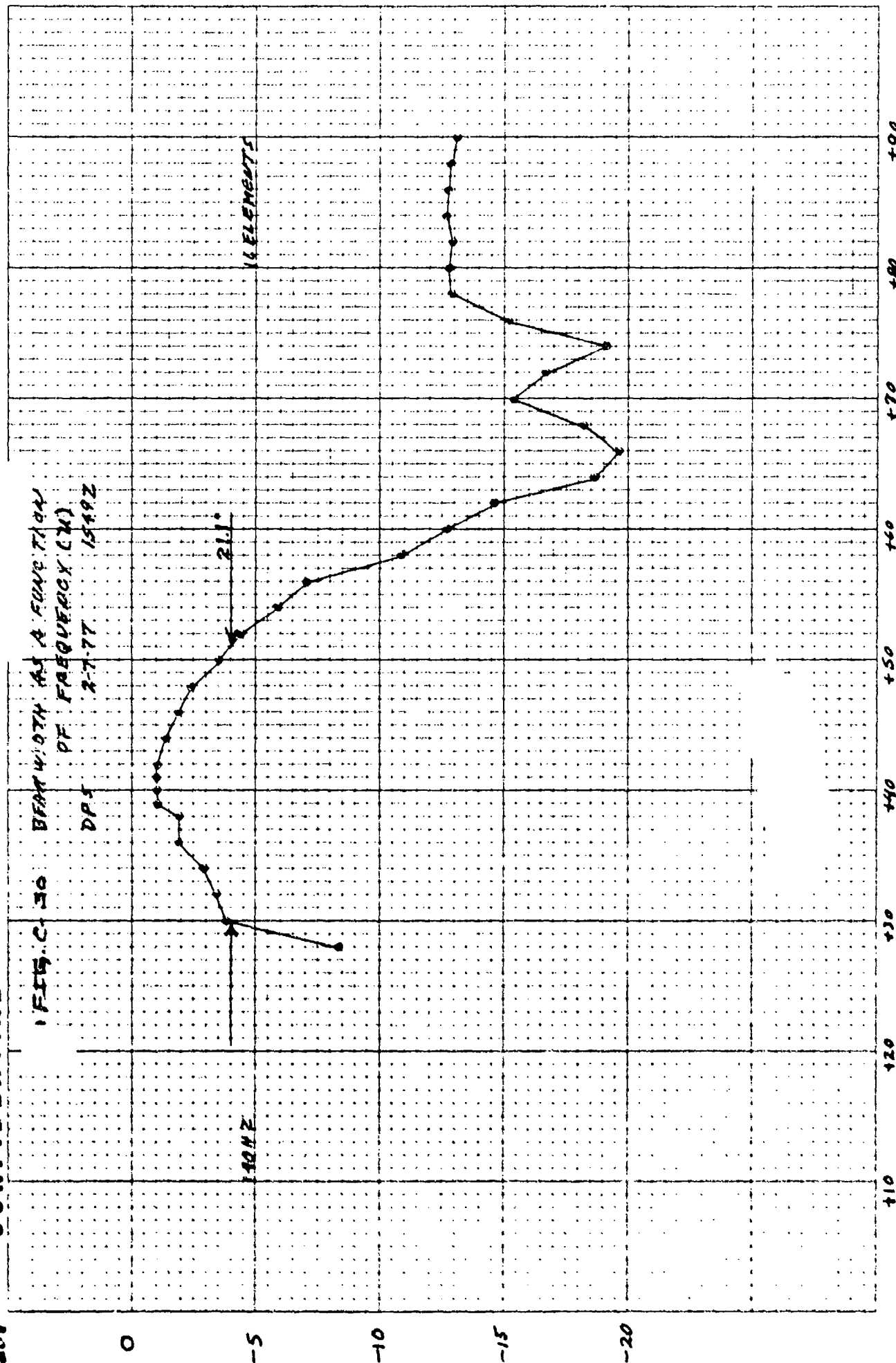
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DATA TO THE PAGES
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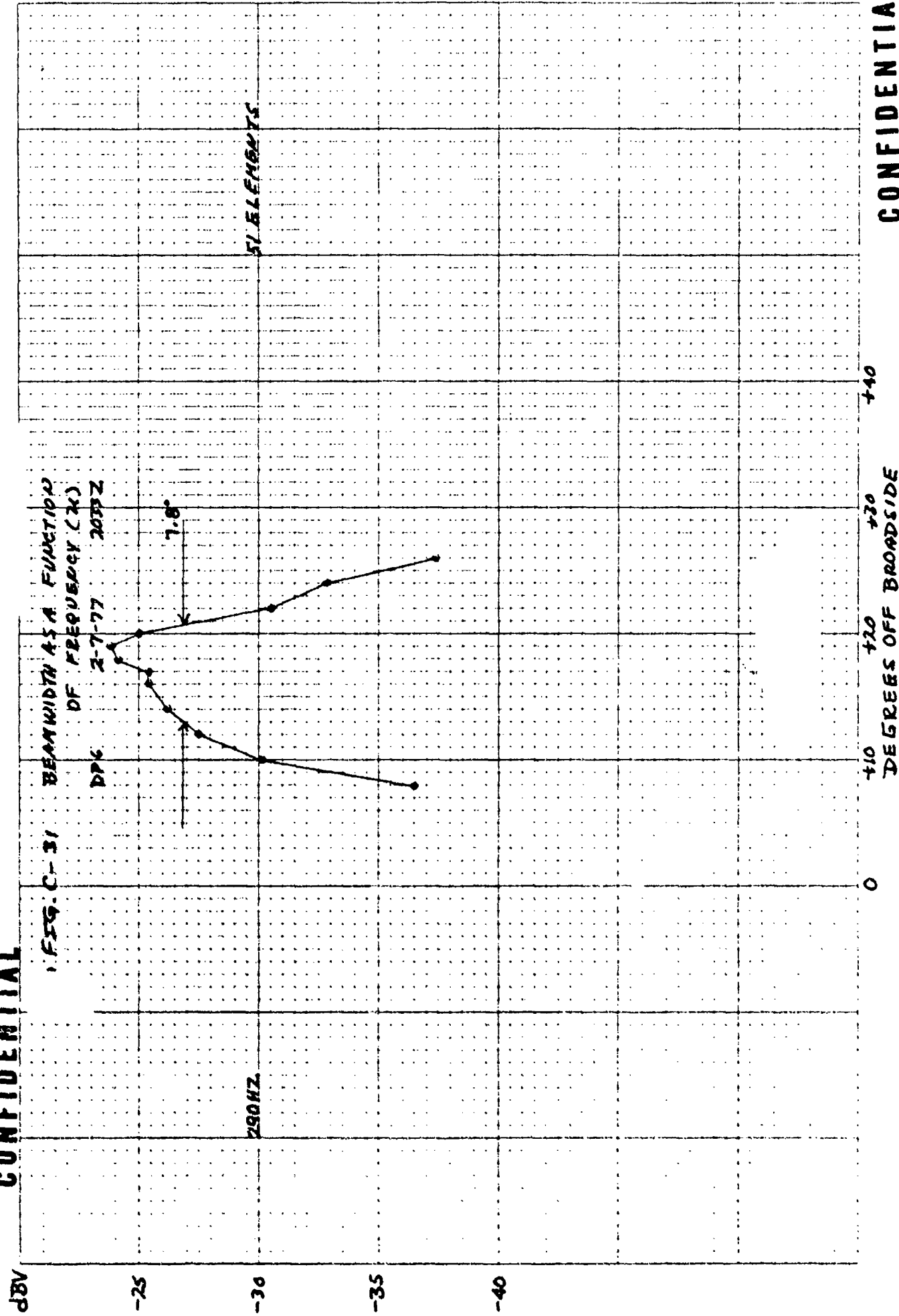
DEGREES OFF BROADSIDE

CONFIDENTIAL

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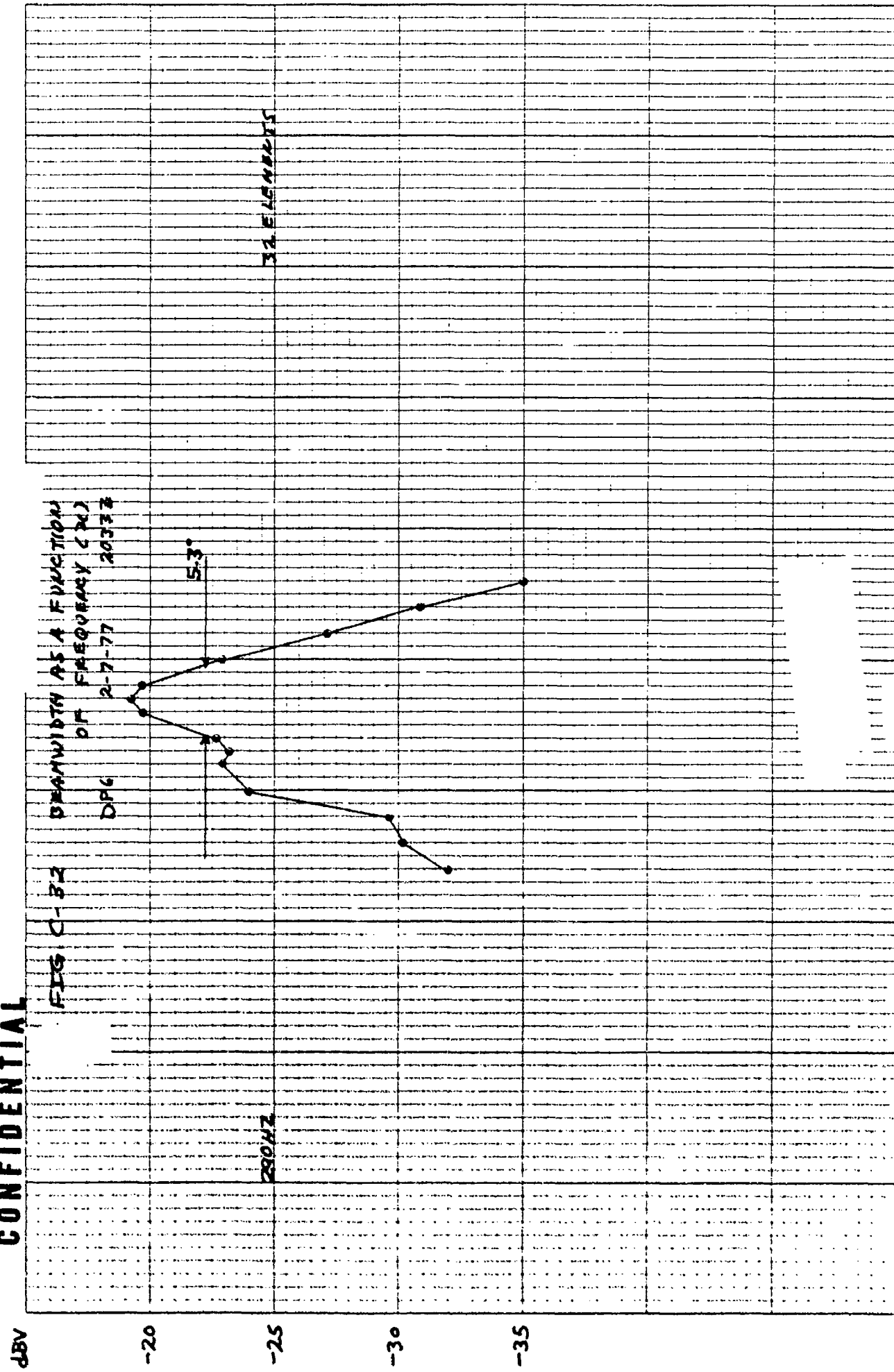
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+40

DEGREES OFF BROADSIDE

0

+20

+30

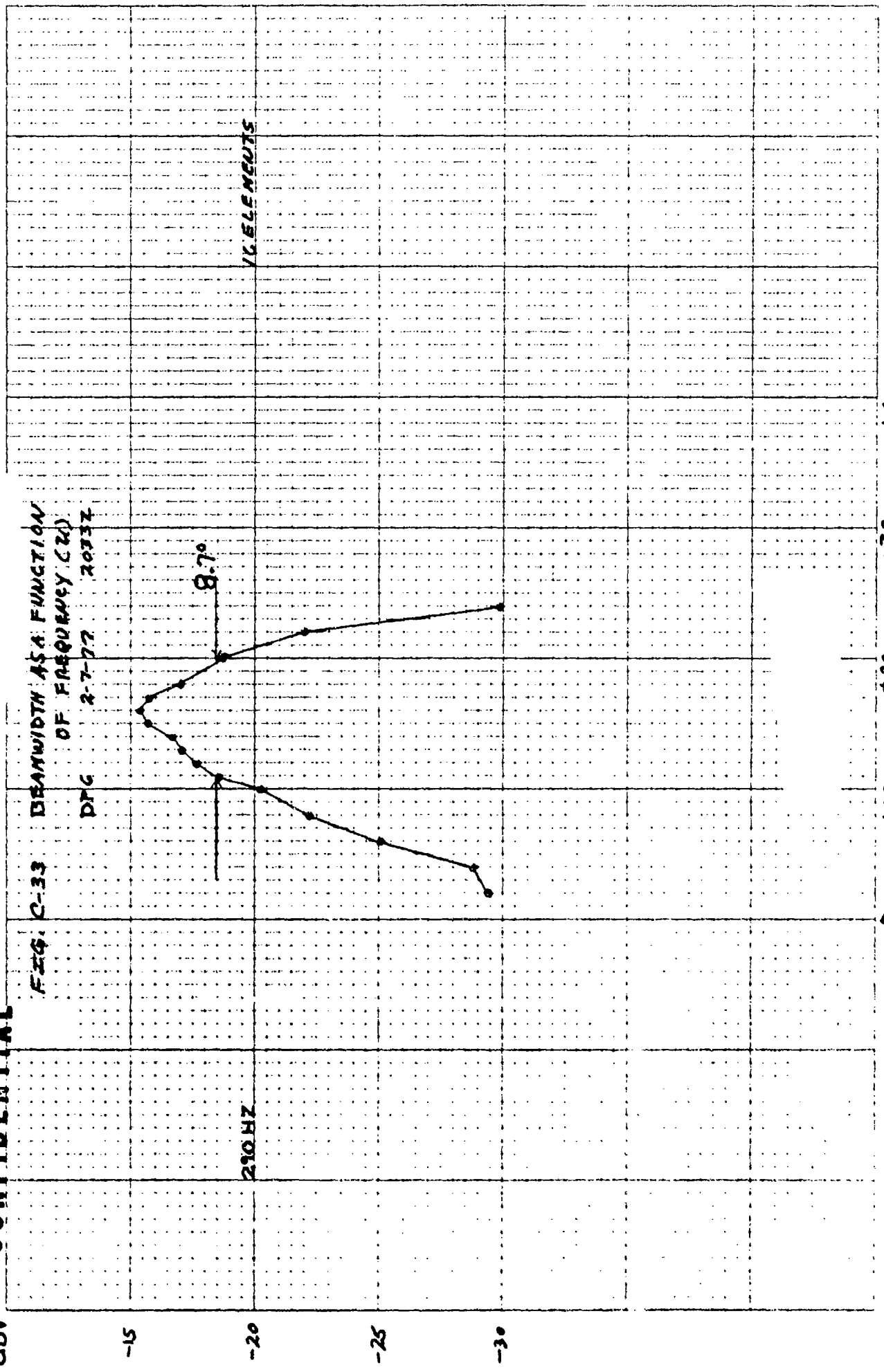
NO. 104 TO THE HONORABLE MEMBERS
OF THE HOUSE OF REPRESENTATIVES
JANUARY 10, 1946

46 U/03

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FIG. C-33 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (CZ)

DFG 2-7-77 2033Z



DEGREES OFF BROADSIDE

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FOR USE IN THE BUREAU OF THE ARMY

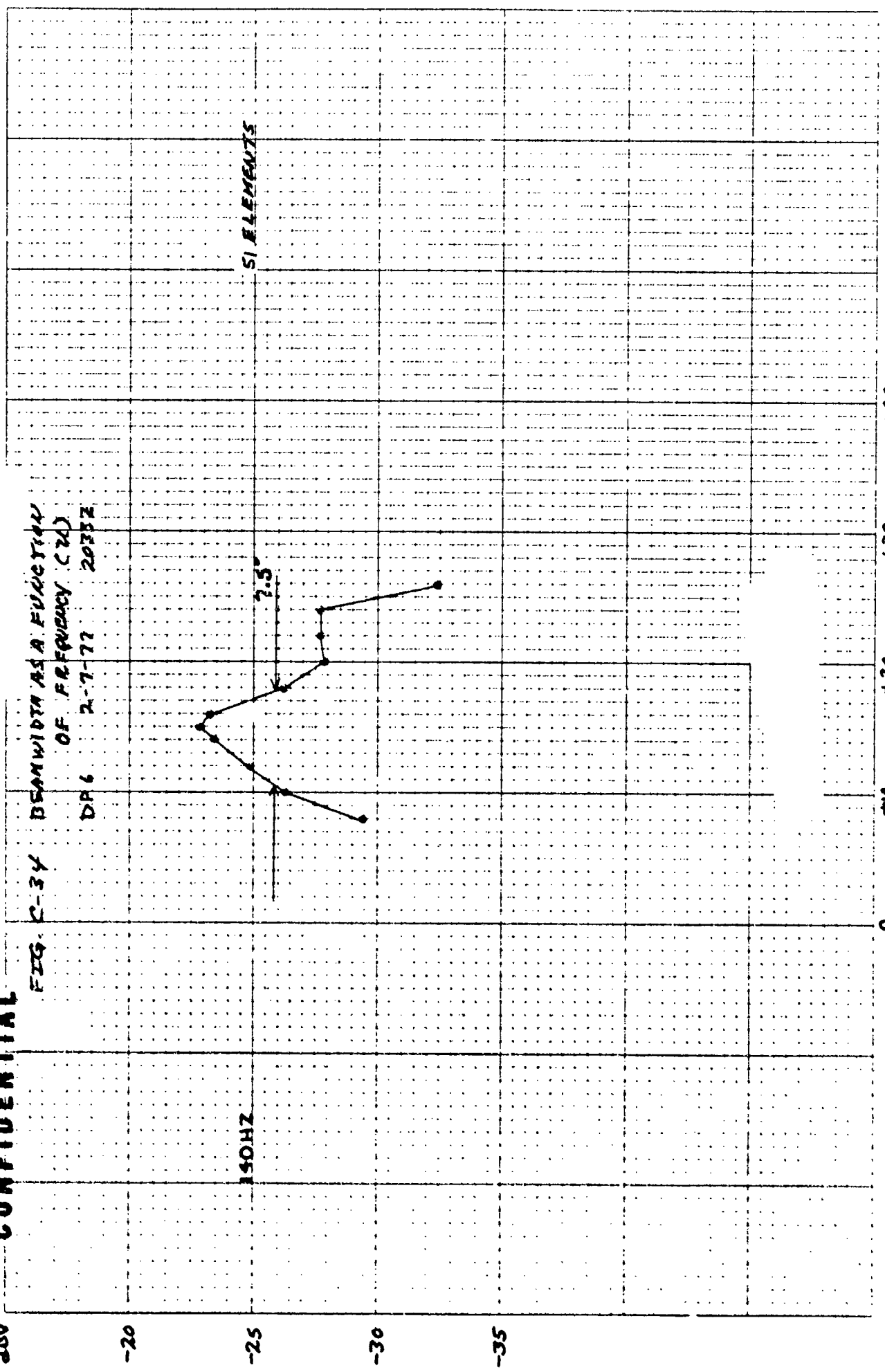


FIG. C-34 BEAMWIDTH AS A FUNCTION OF FREQUENCY (Hz)
DPL 2-7-77 2035Z

S1 ELEMENTS

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DEGREES OFF BROADSIDE

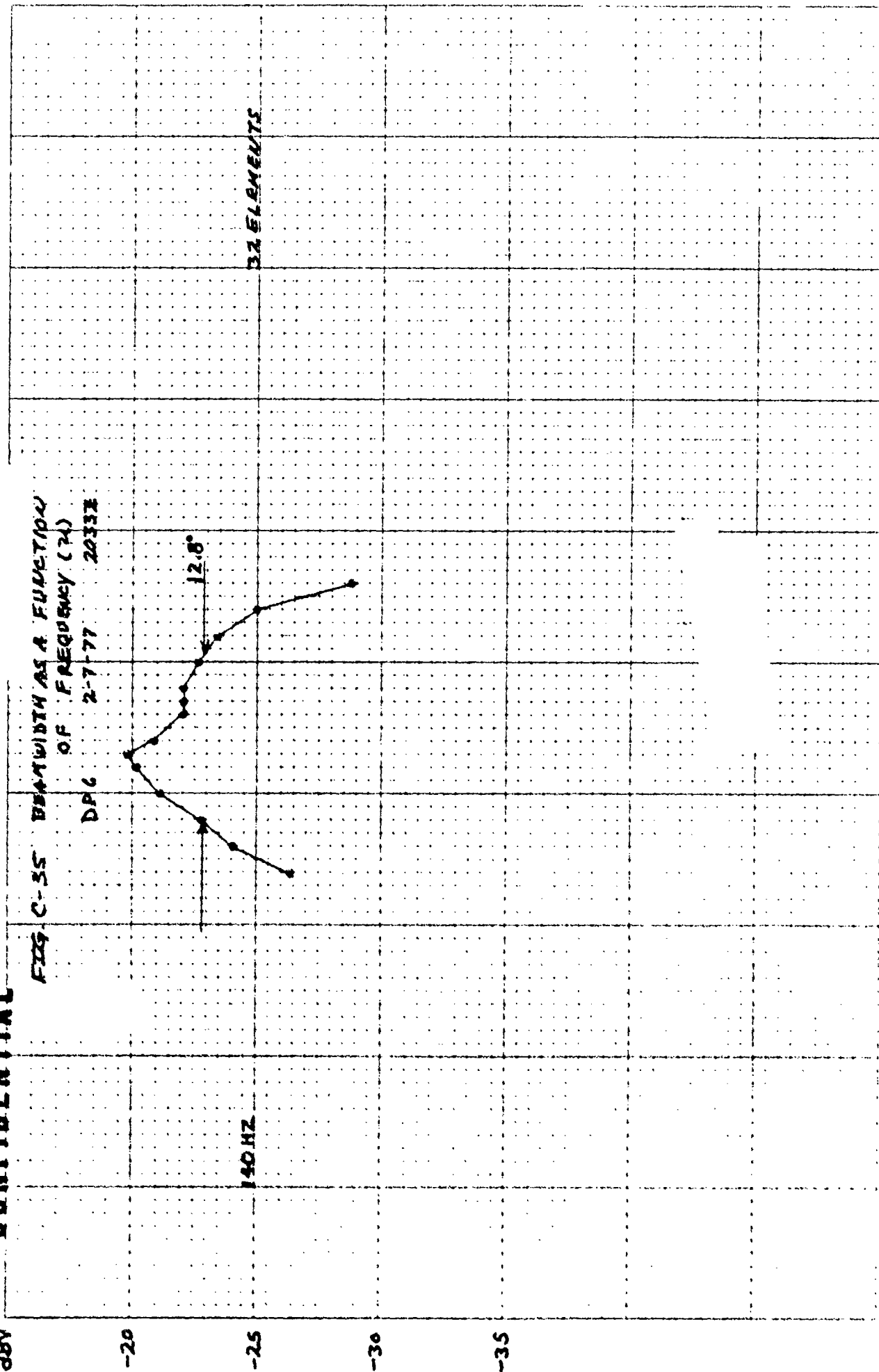
46 0703

15-E 10-10-77 10-10-77 10-10-77

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FIG C-35 BANDWIDTH AS A FUNCTION
OF FREQUENCY (74)

DPG 2-7-77 20332



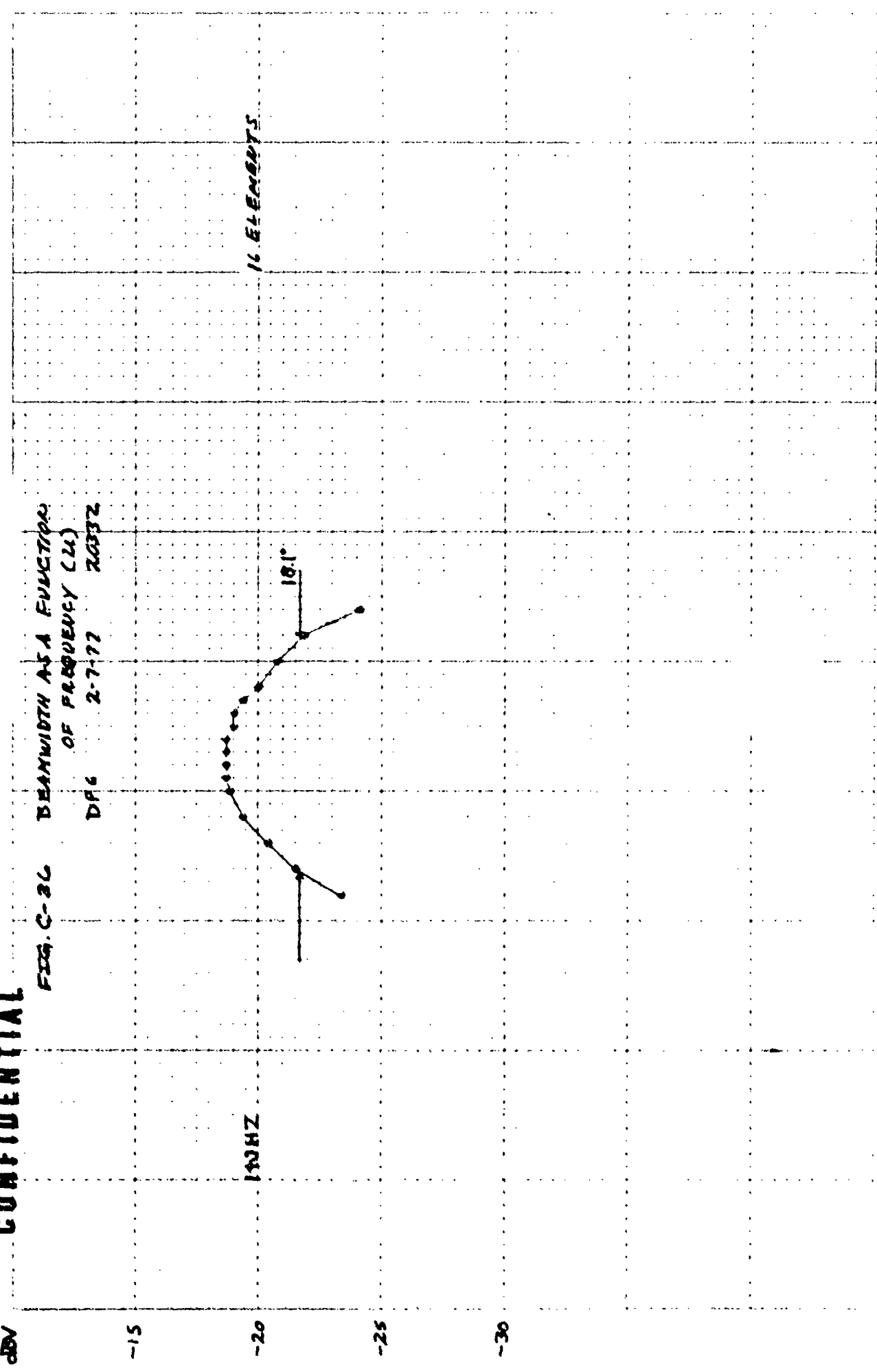
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FIG. C-36 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (MHz)
DPL 2-7-77 20332



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0 120 130 140
DEGREES OFF BROADSIDE

CONFIDENTIAL

38V

-15

-20

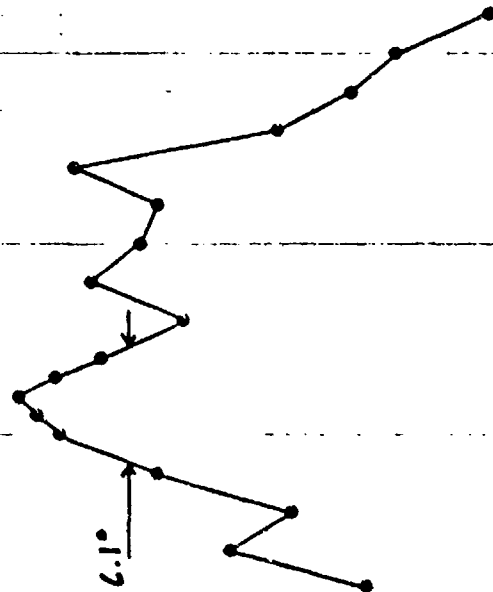
-25

-30

290HZ

SIELEMENTS

FIG. C-37 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DP7 2-8-77 0202Z



-10

-20

-30

-40

-50

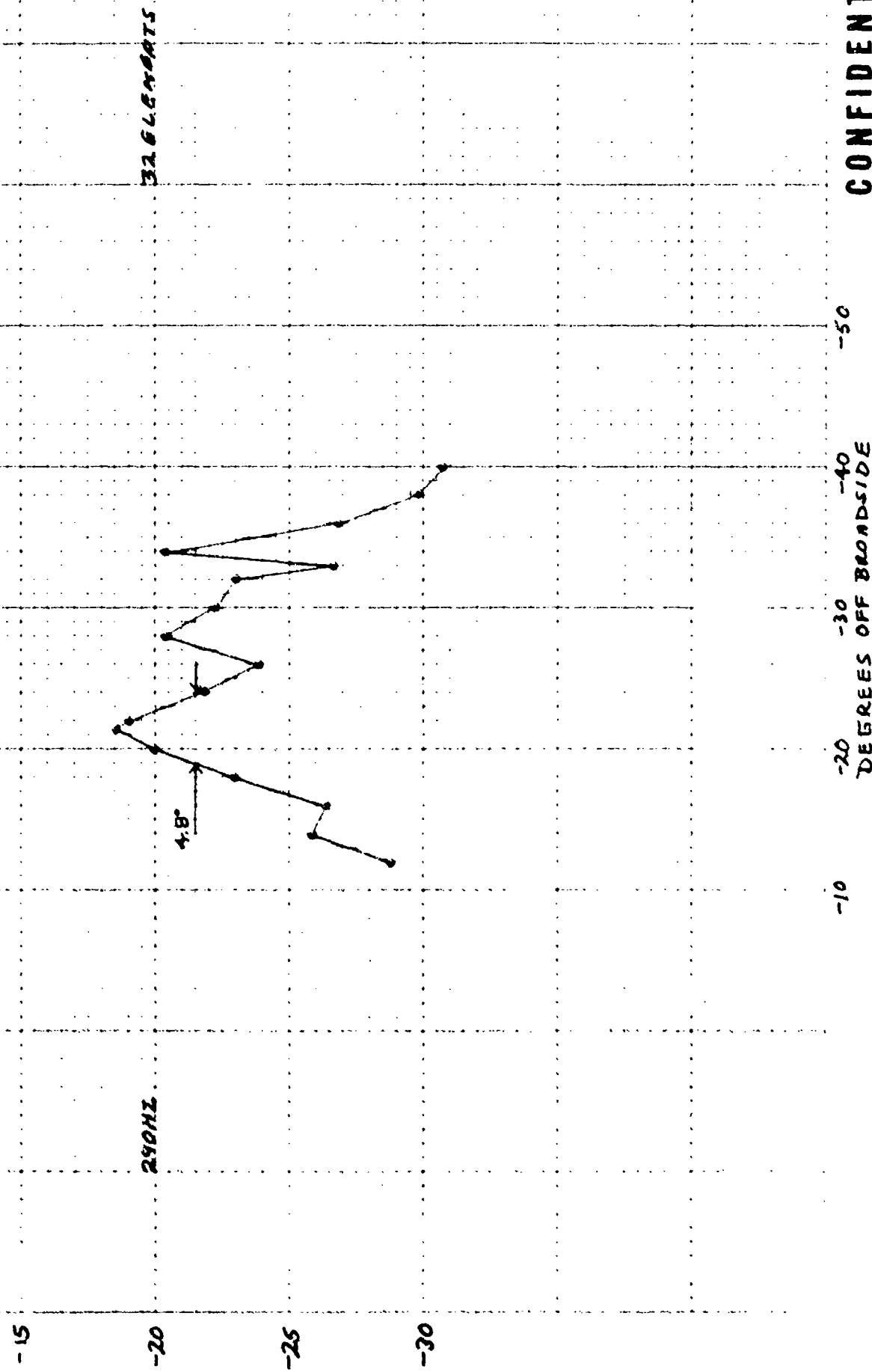
DEGREES OFF BROADSIDE

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100

CONFIDENTIAL

FIG. C-38
BANDWIDTH AS A FUNCTION
OF FREQUENCY (24)
PP 2-8-77 0301Z



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FIG. C-40 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DP7 2-8-77 0202Z

-10

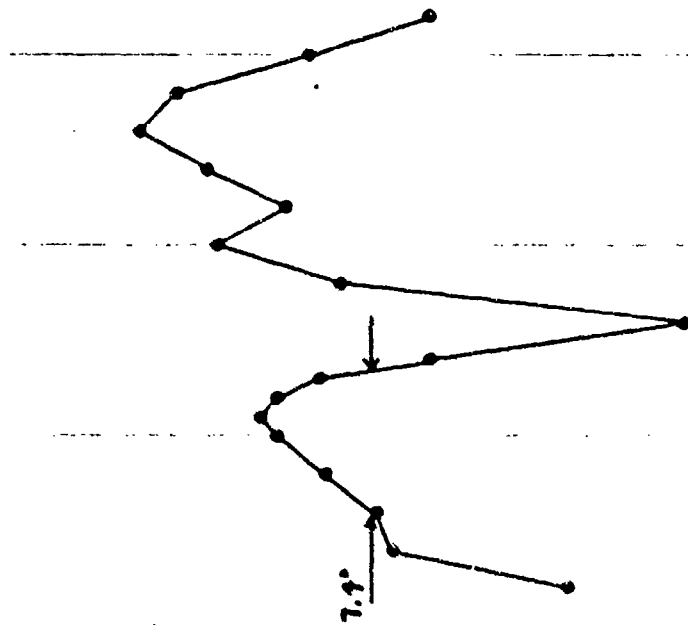
140Hz

-15

-20

-25

SIELEMENTS



-10

-20
DEGREES OFF-BROADSIDE

-30

-40

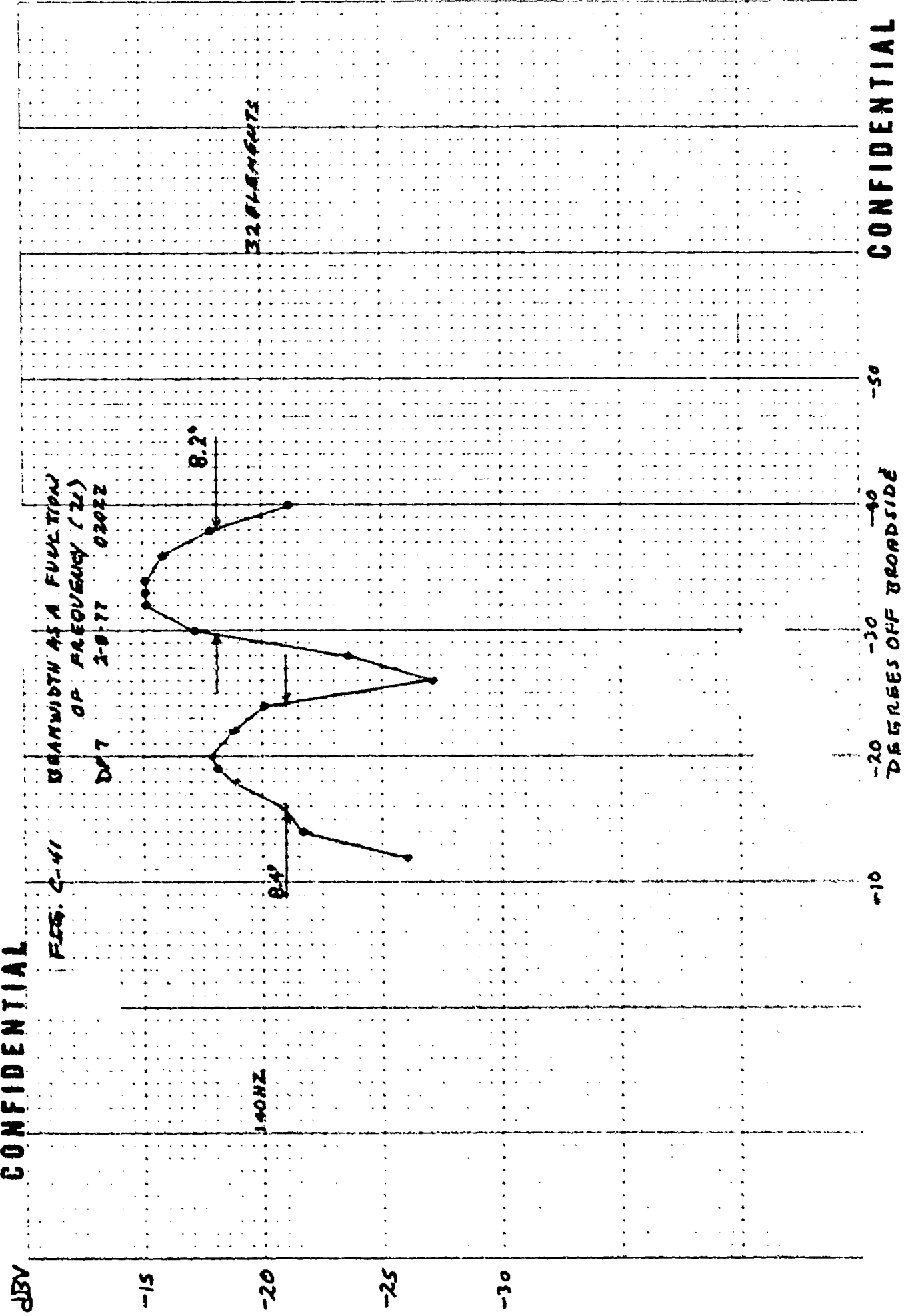
-50

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dBV

FIG. C-42 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (MHz)
DP7 2-8.77 02012

140 HZ

16 ELEMENTS

(8.8)

-10

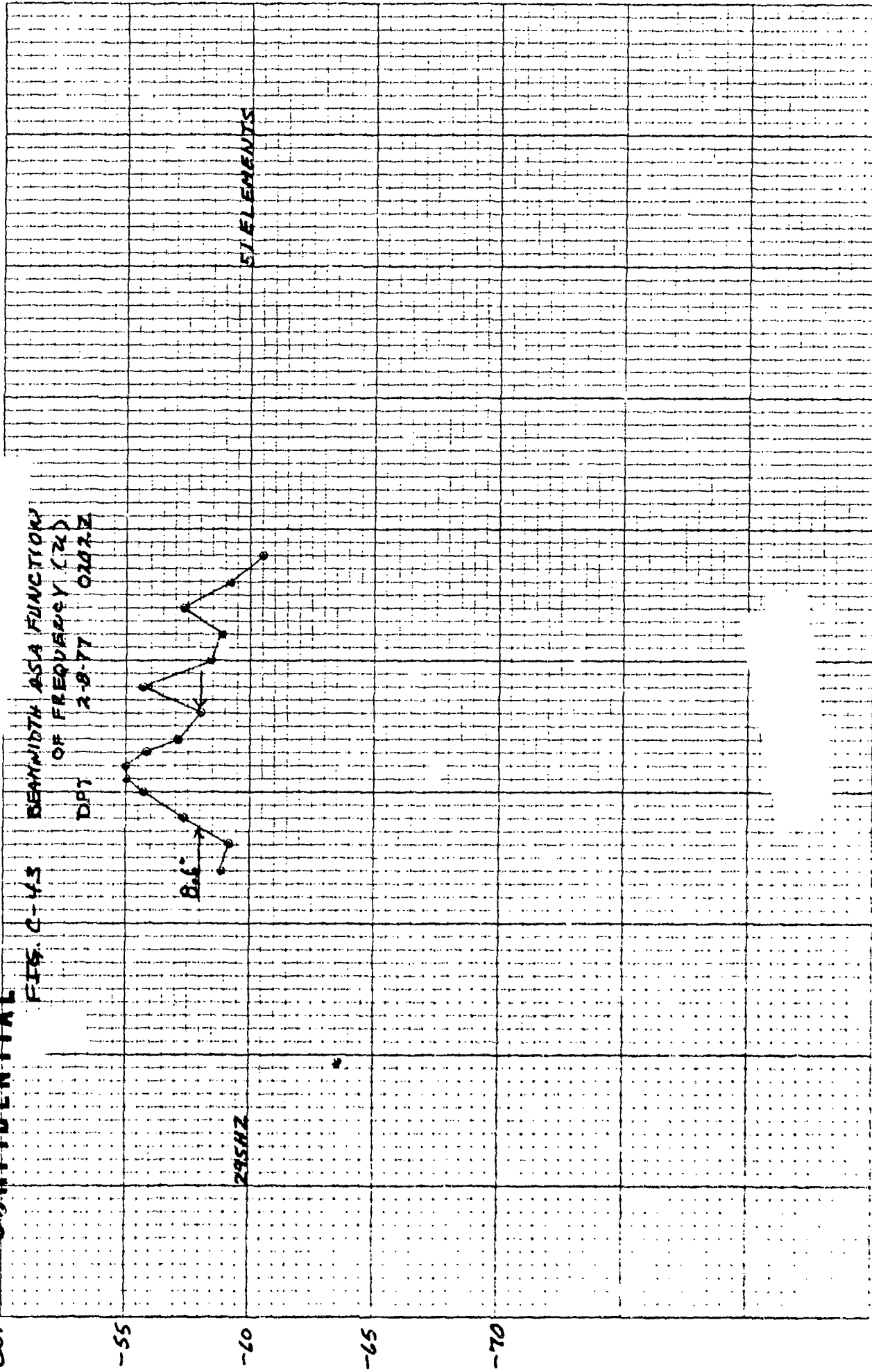
-20 DEGREES OFF BROADSIDE

-50

CONFIDENTIAL

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FIG. C-43 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DPT 2-8-77 0202Z



-20 -30 -40 -50
DEGREES OFF BROADSIDE

CONFIDENTIAL

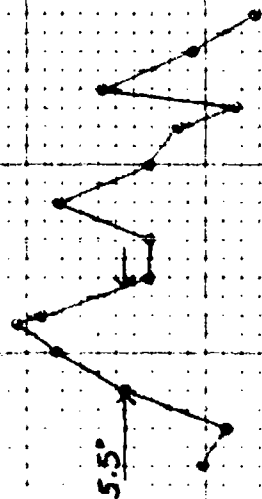
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MOE PLANT TO THE JACOBI

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FIG C-114 BANDWIDTH AS A FUNCTION
OF FREQUENCY (Hz)

DP 7 2-8-77 0702Z



205HZ

12 ELEMENTS

-10

-20

-30

-40

-50

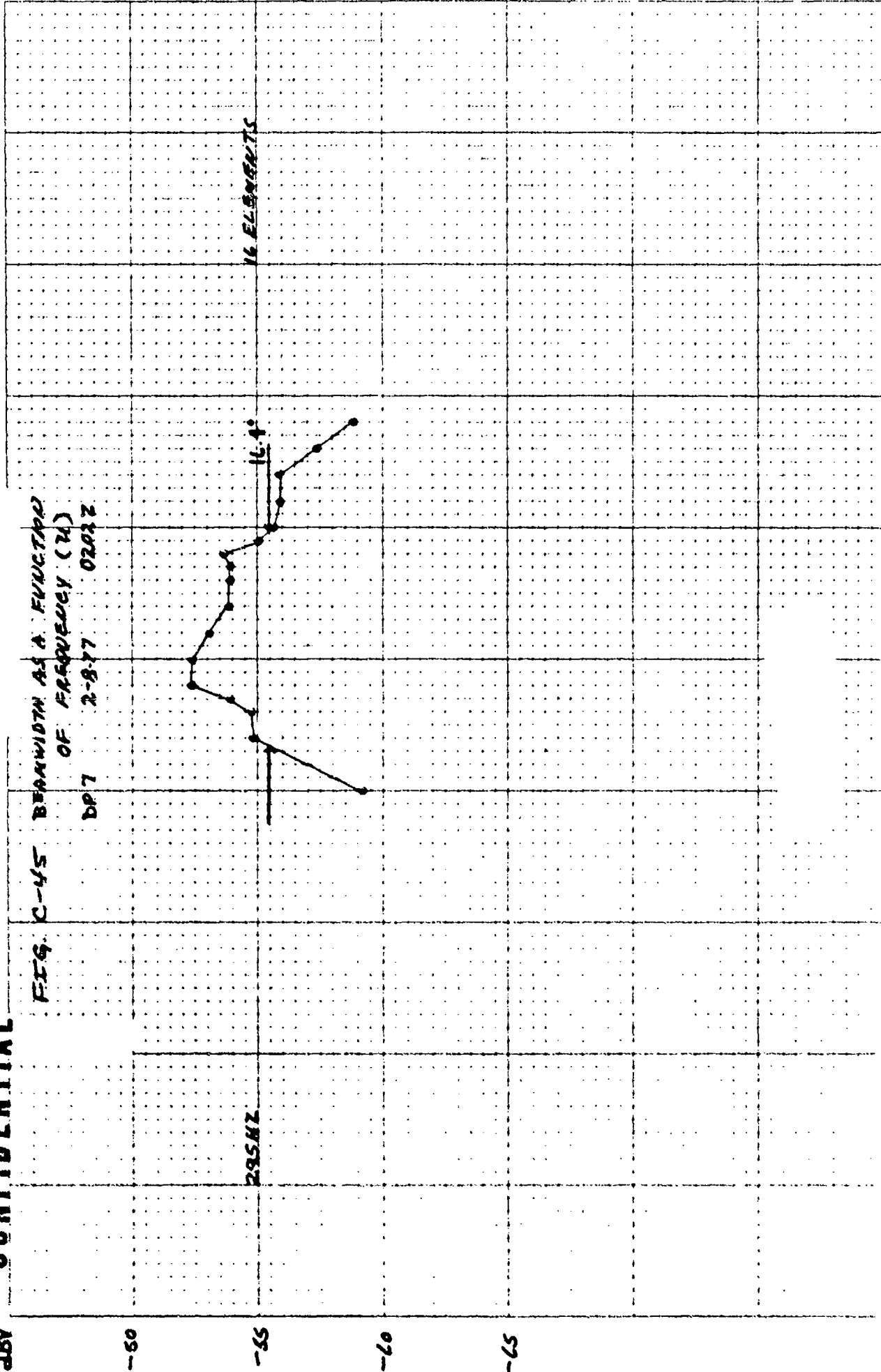
DEGREES OFF BROADSIDE

CONFIDENTIAL

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FIG. C-45 BEAMWIDTH AS A FUNCTION OF FREQUENCY (Hz)

DP7 2-8-77 0203Z



29.5 MHz

16.4 MHz

16 ELEMENTS

-40

-30

-20

-10

0

DEGREES OFF BROADSIDE

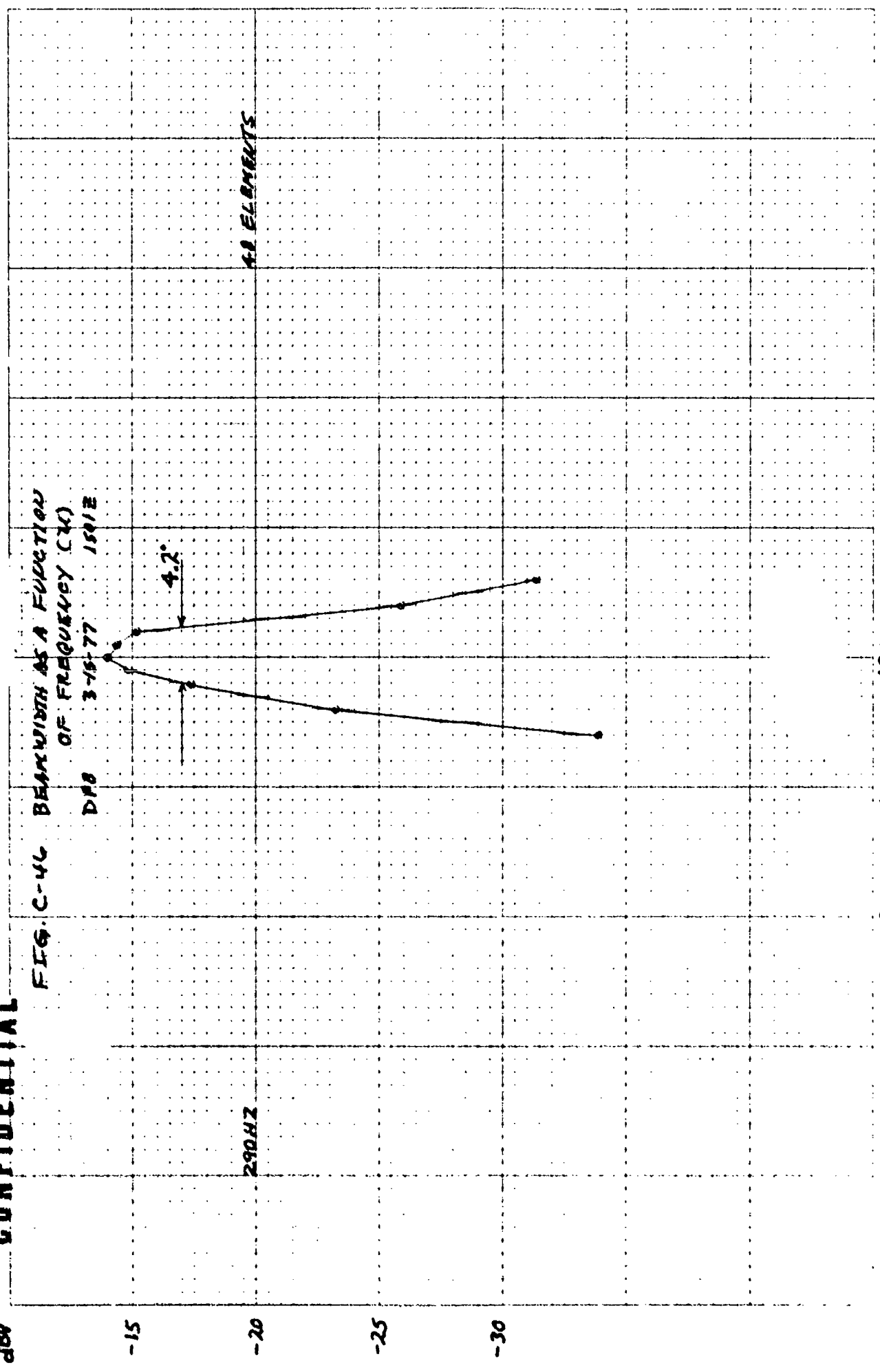
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K-E IS 14 TO THE 150000
REURTEL 150000 CC 150000

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FIG. C-46 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DPO 3-15-77 15012



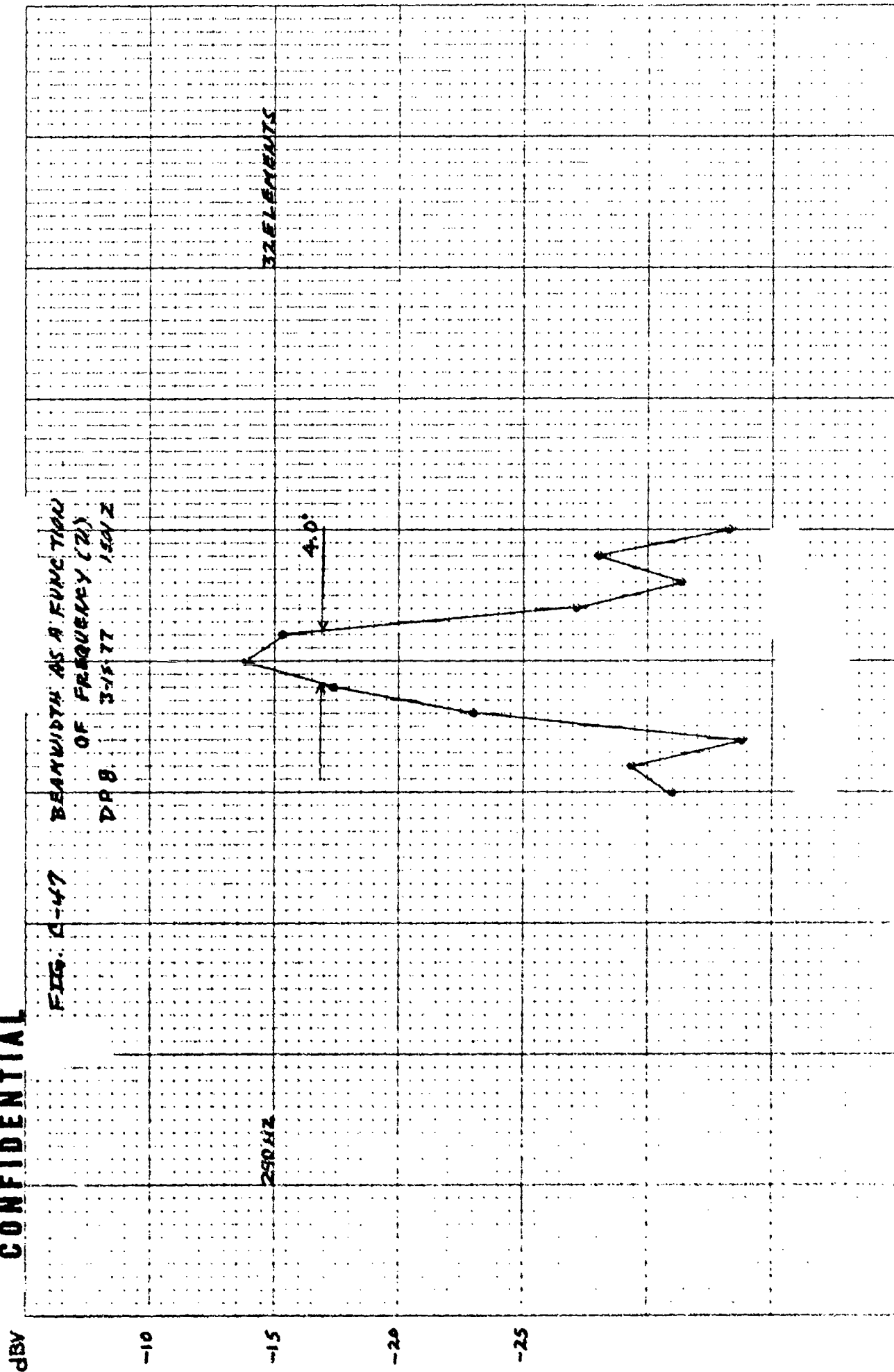
0 10 20 40
DEGREES OF BEAMWIDE

CONFIDENTIAL

FIG. 1-47 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (2)

46 UJ03

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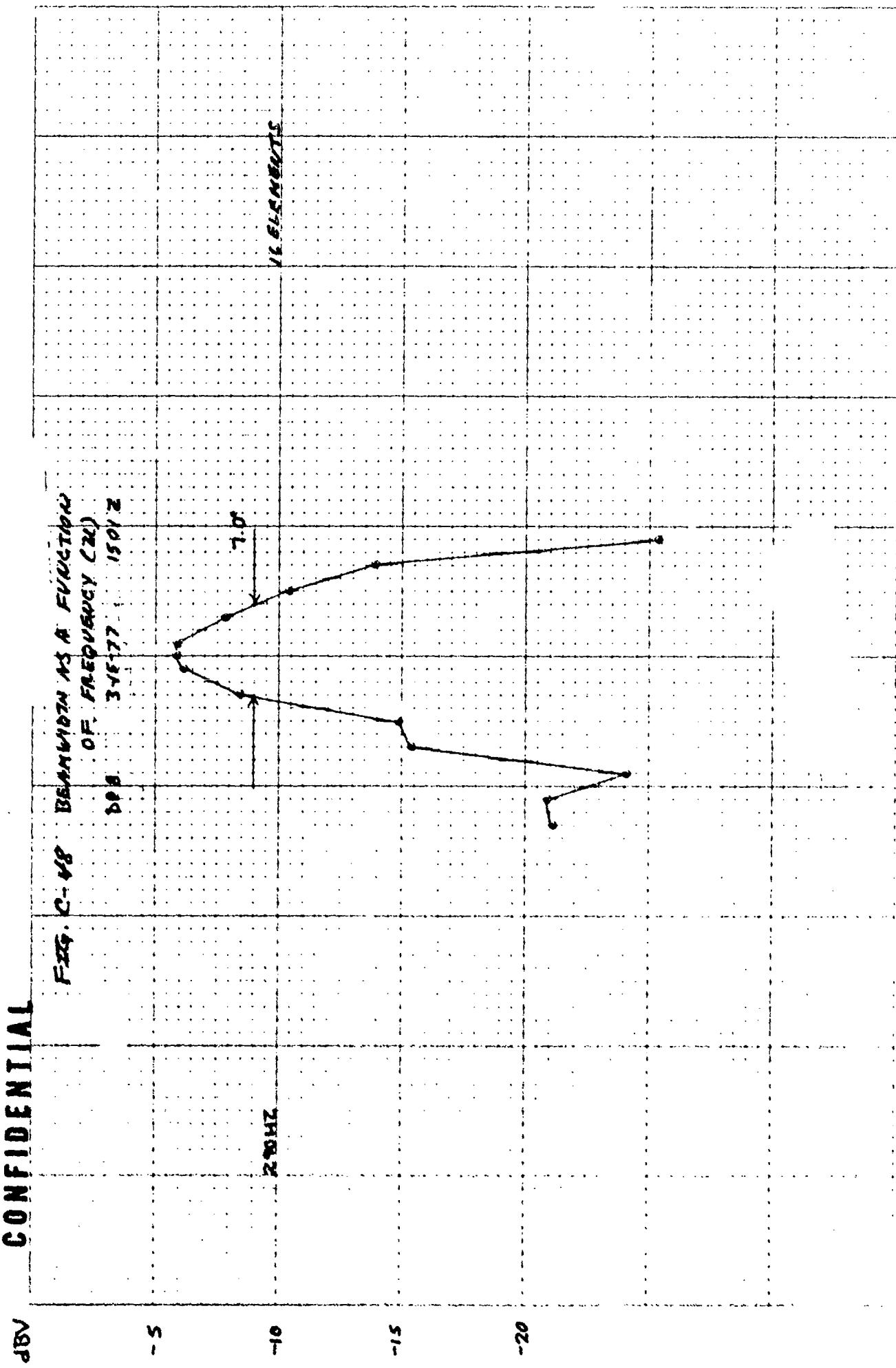
DEGREES OFF BROADSIDE

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K02 PLATE TO THE INCHES

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46 u/v3

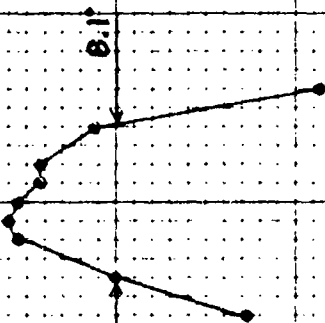
CONFIDENTIAL

FIG. C-49 BEAM WIDTH AS A FUNCTION OF FREQUENCY (24)

DP# 3-15-77 1501 E

ZH05

540943 11 84



	+10	+20	+30
DMEGEE OFF BROADSIDE			

140

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7021

46 v, v3

CONFIDENTIAL

ADP

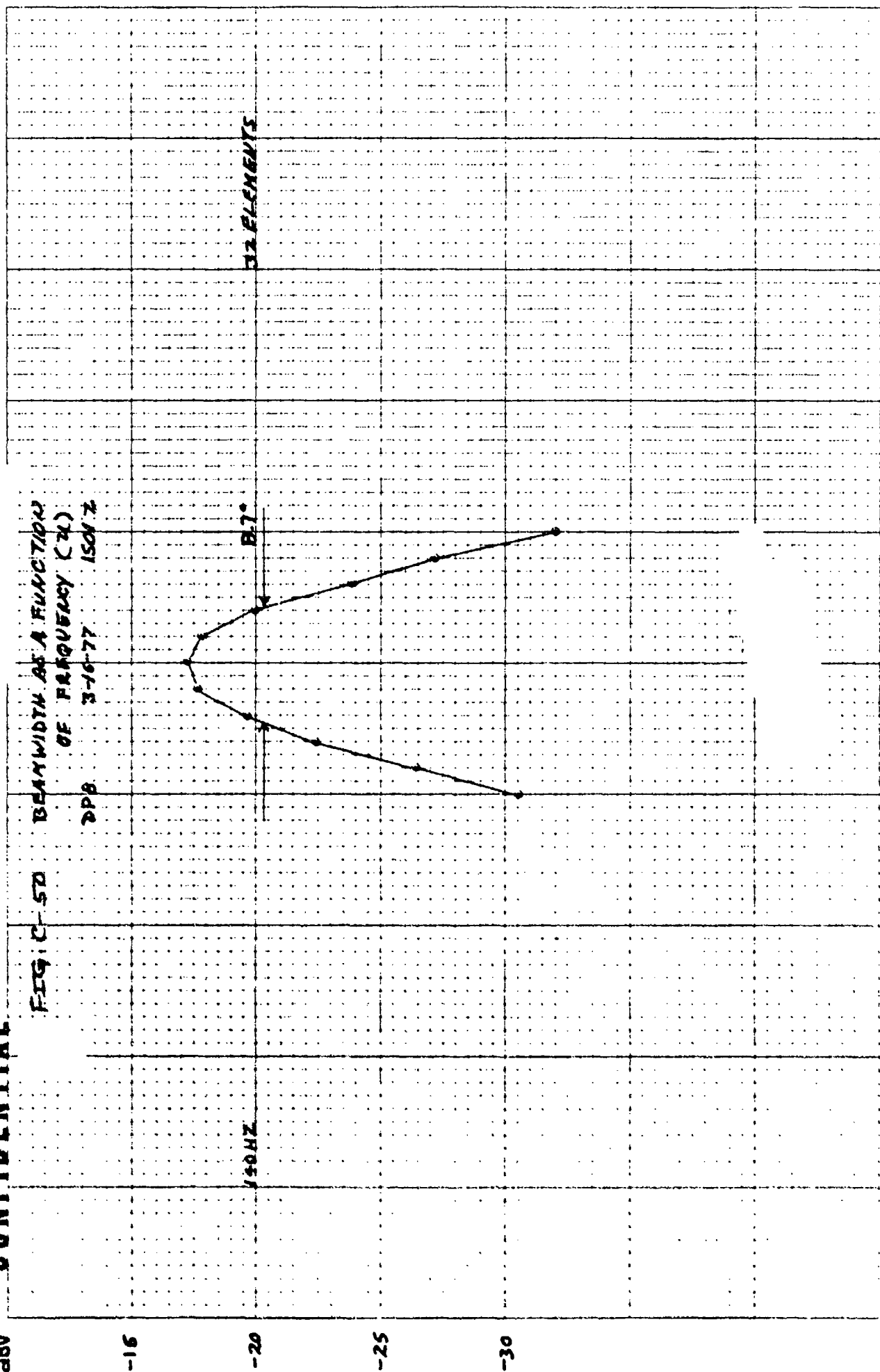
FIG. C-50 BEAMWIDTH AS A FUNCTION OF FREQUENCY (Hz)

DPB	3-10-77	15N-2
1	1.0	1.0
2	1.0	1.0
3	1.0	1.0
4	1.0	1.0
5	1.0	1.0
6	1.0	1.0
7	1.0	1.0
8	1.0	1.0
9	1.0	1.0
10	1.0	1.0
11	1.0	1.0
12	1.0	1.0
13	1.0	1.0
14	1.0	1.0
15	1.0	1.0
16	1.0	1.0
17	1.0	1.0
18	1.0	1.0
19	1.0	1.0
20	1.0	1.0
21	1.0	1.0
22	1.0	1.0
23	1.0	1.0
24	1.0	1.0
25	1.0	1.0
26	1.0	1.0
27	1.0	1.0
28	1.0	1.0
29	1.0	1.0
30	1.0	1.0
31	1.0	1.0
32	1.0	1.0
33	1.0	1.0
34	1.0	1.0
35	1.0	1.0
36	1.0	1.0
37	1.0	1.0
38	1.0	1.0
39	1.0	1.0
40	1.0	1.0
41	1.0	1.0
42	1.0	1.0
43	1.0	1.0
44	1.0	1.0
45	1.0	1.0
46	1.0	1.0
47	1.0	1.0
48	1.0	1.0
49	1.0	1.0
50	1.0	1.0

ZHOS

五

12 ELEMENTS



+ 40

+30

20

10

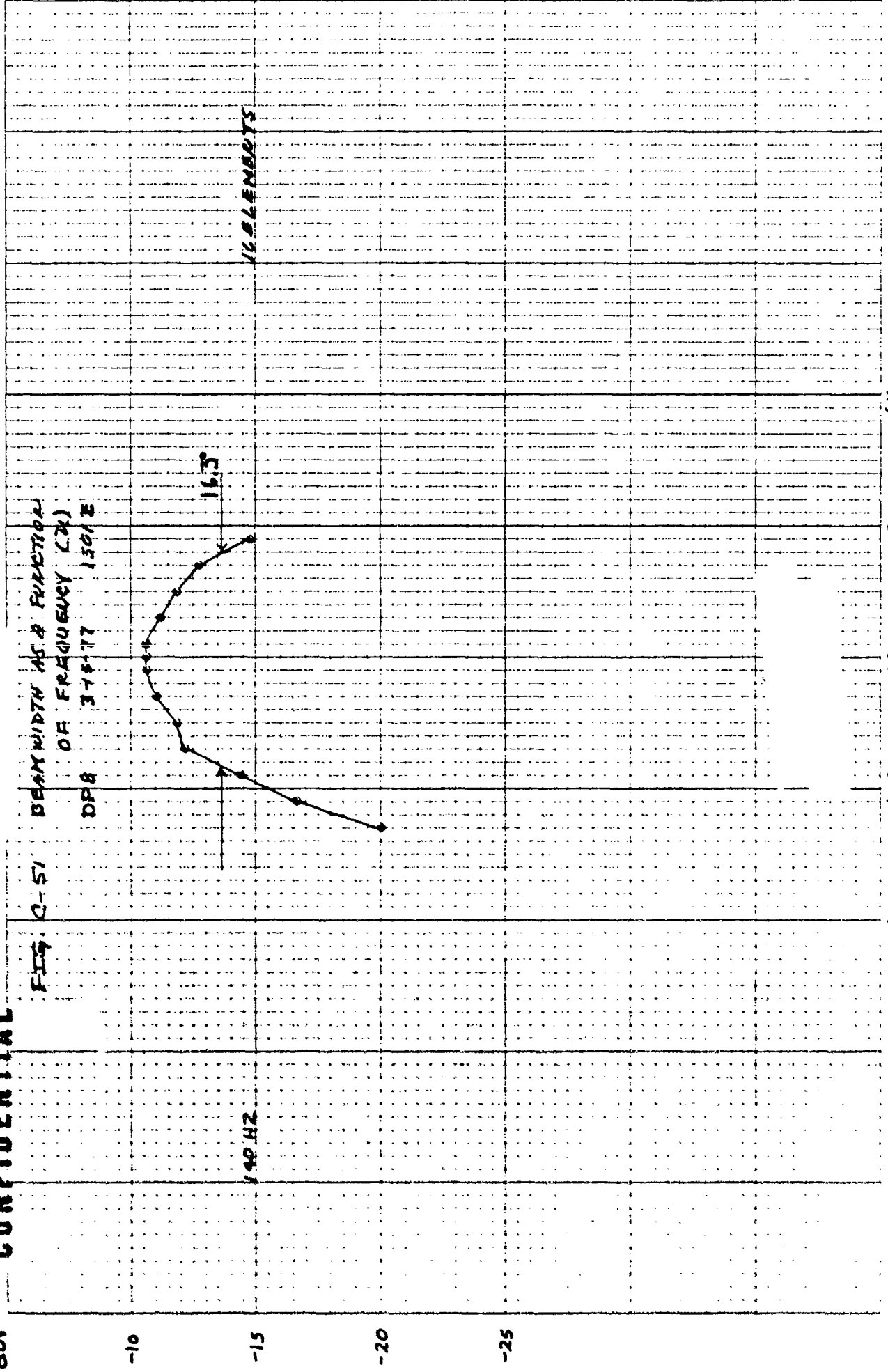
○

	+10	+20	+30
DEGREES OFF TRACKSIDE			

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FIG. Q-51 BEAM WIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DPA 378-77 1501E



DEGREES OFF BROADSIDE

+40

+30

+20

+10

0

-10

-20

-30

-40

CONFIDENTIAL

362

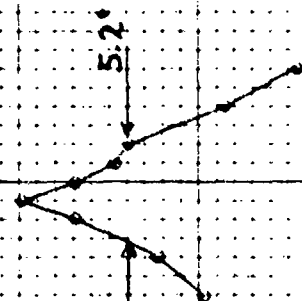
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FIG. C-52 BANDWIDTH AS A FUNCTION OF FREQUENCY (Hz)

DP#	3-4-17	15012
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ZH 502

5170473 04



+10 +20 +30
DE GREES OFF BROADSIDE

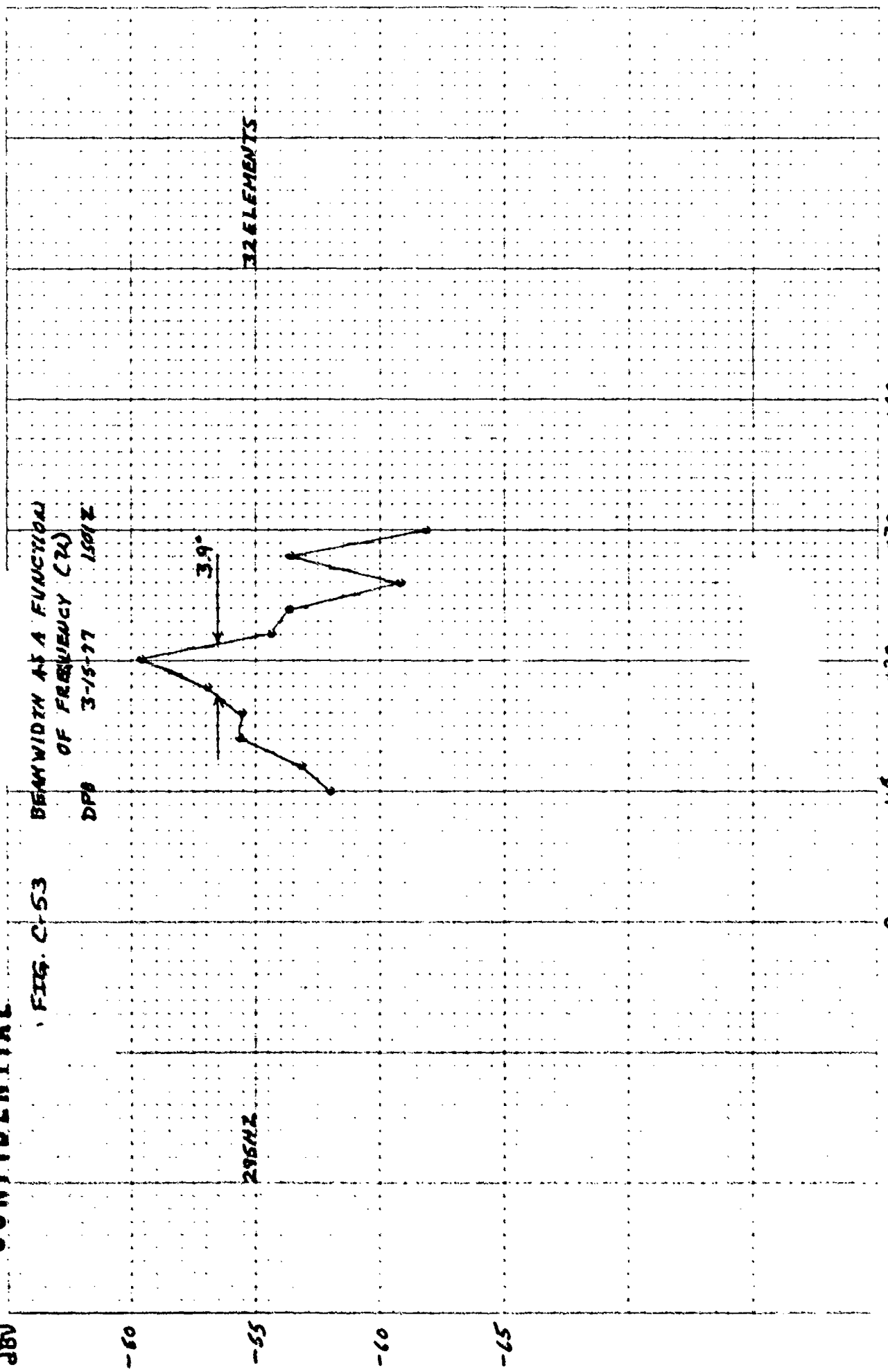
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46 0103

NOE PLANT GARDENING UNIT

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FIG. C-53 BEAMWIDTH AS A FUNCTION OF FREQUENCY (74)
DPA 3-15-77 1501Z



DEGREES OFF BROADSIDE

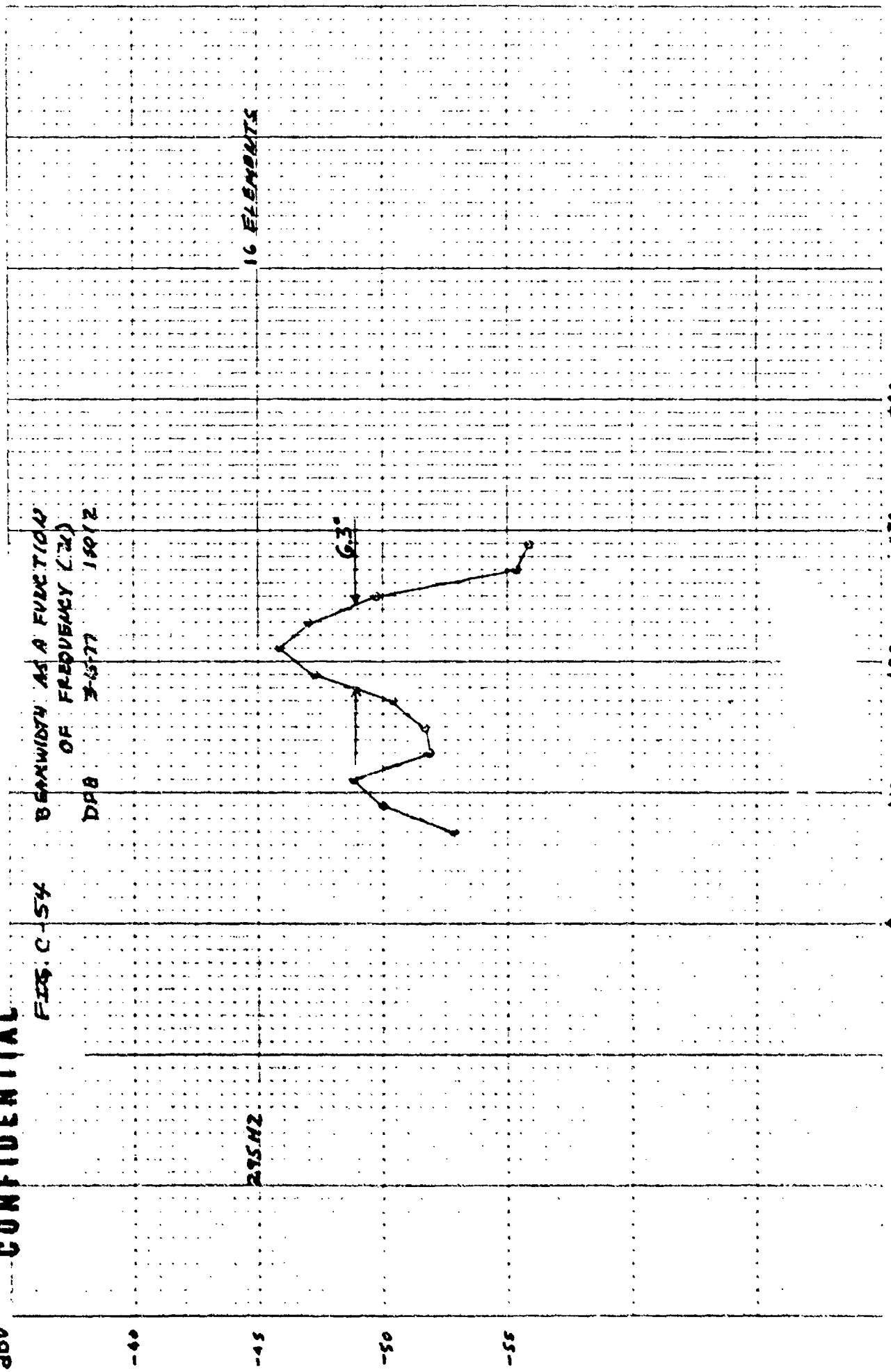
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NOE PLANT 1000 1000 1000

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FIG. C-54 BANDWIDTH AS A FUNCTION OF FREQUENCY (20) DBB 3-577 10012



DEGREES OFF BROADSIDE

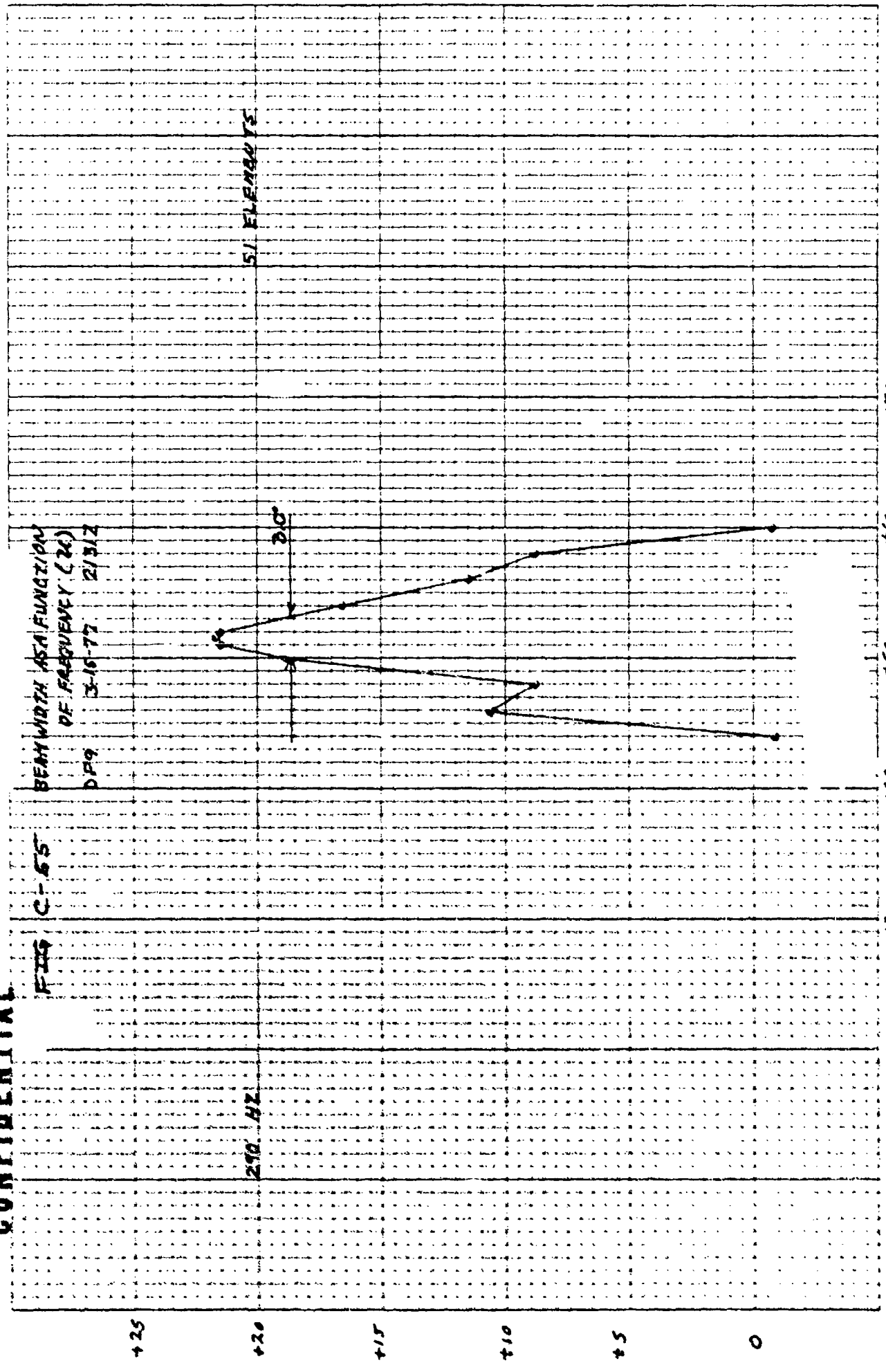
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FIG C-55

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DEGREES OFF BRANDSIDE

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BEAMWIDTH AS A FUNCTION
OF FREQUENCY (20)

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32 ELEMENTS

•

40.

54

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470

440 450 460
NEELES OFF BROADSIDE

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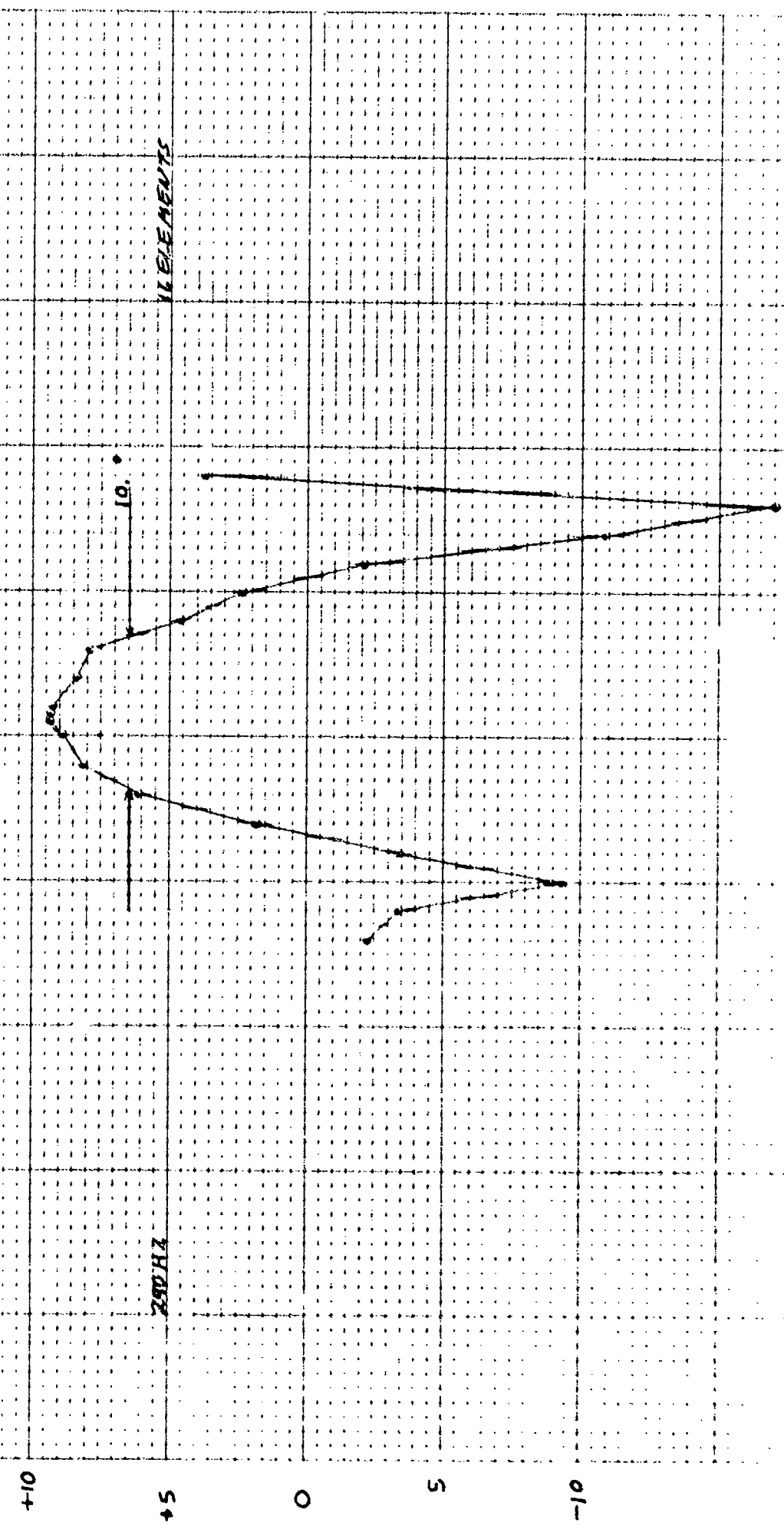
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FIG. C-57 BEAM WIDTH AS A FUNCTION OF FREQUENCY (2U)

DP 9 3-16-77 2111Z



70

+40

050

294

70

DEGREES OFF BROADSIDE

CONFIDENTIAL

CONFIDENTIAL

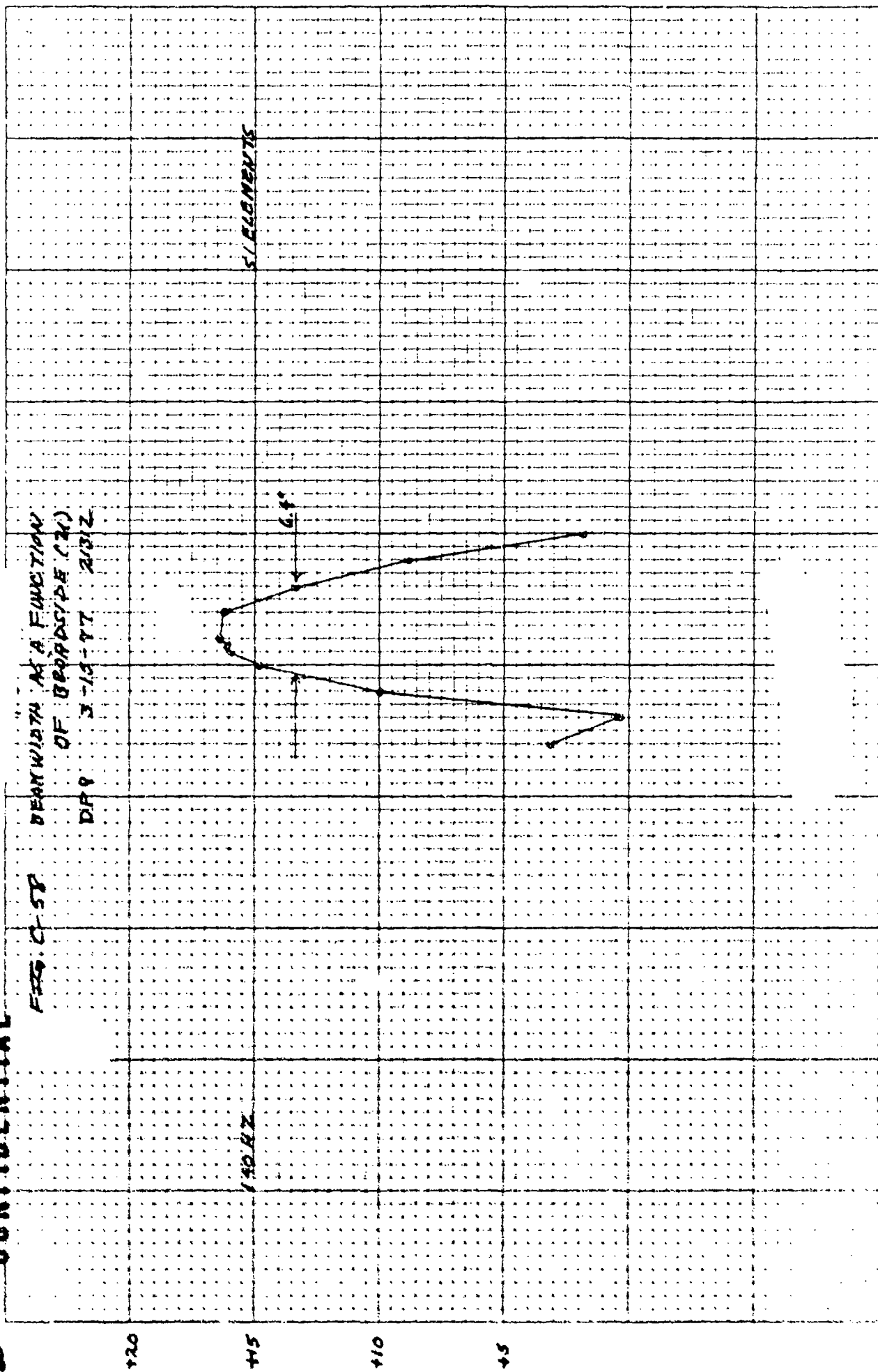
+70 +60 +50 +40
DEGREES OFF BROADSIDE

46 U/03

ROE PLAIN TO THE INCHES 2.5 INCHES

CONFIDENTIAL

FIG. C-58 BEAMWIDTH AS A FUNCTION
OF BROADSIDE (24)
DRG 3-13-77 21312



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+70 +60 +50 +40
DEGREES OFF BROADSIDE

CONFIDENTIAL

dB

FIG. C-59 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (MHz)

DPR 3-15-77 2/30Z

100 Hz

10.0'

32 ELEMBOTS

130

140

150

160

170

DEGREES OFF BROADSIDE

CONFIDENTIAL

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7. TO THE SECRETARY OF THE NAVY DEPARTMENT WASHINGTON D. C.

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BEAMWIDTH AS A FUNCTION
OF FREQUENCY (22)
DP9 3-15-77 2131Z

16 ELEMENTS

25

470

074

084

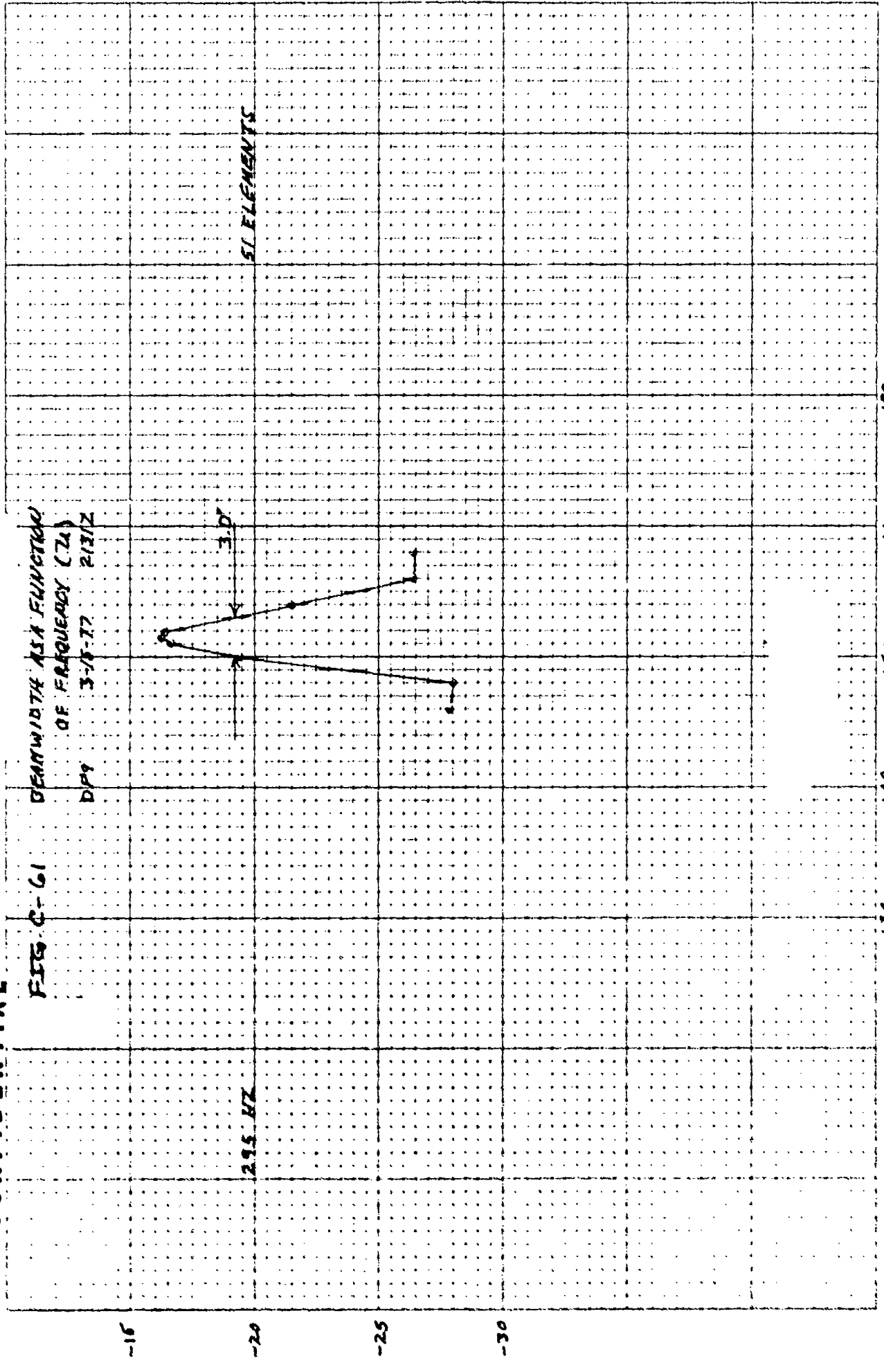
140

430

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DBP
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FIG. C-61 BEAMWIDTH AS A FUNCTION
 OF FREQUENCY (7A)
 DP9 3-18-77 2131Z

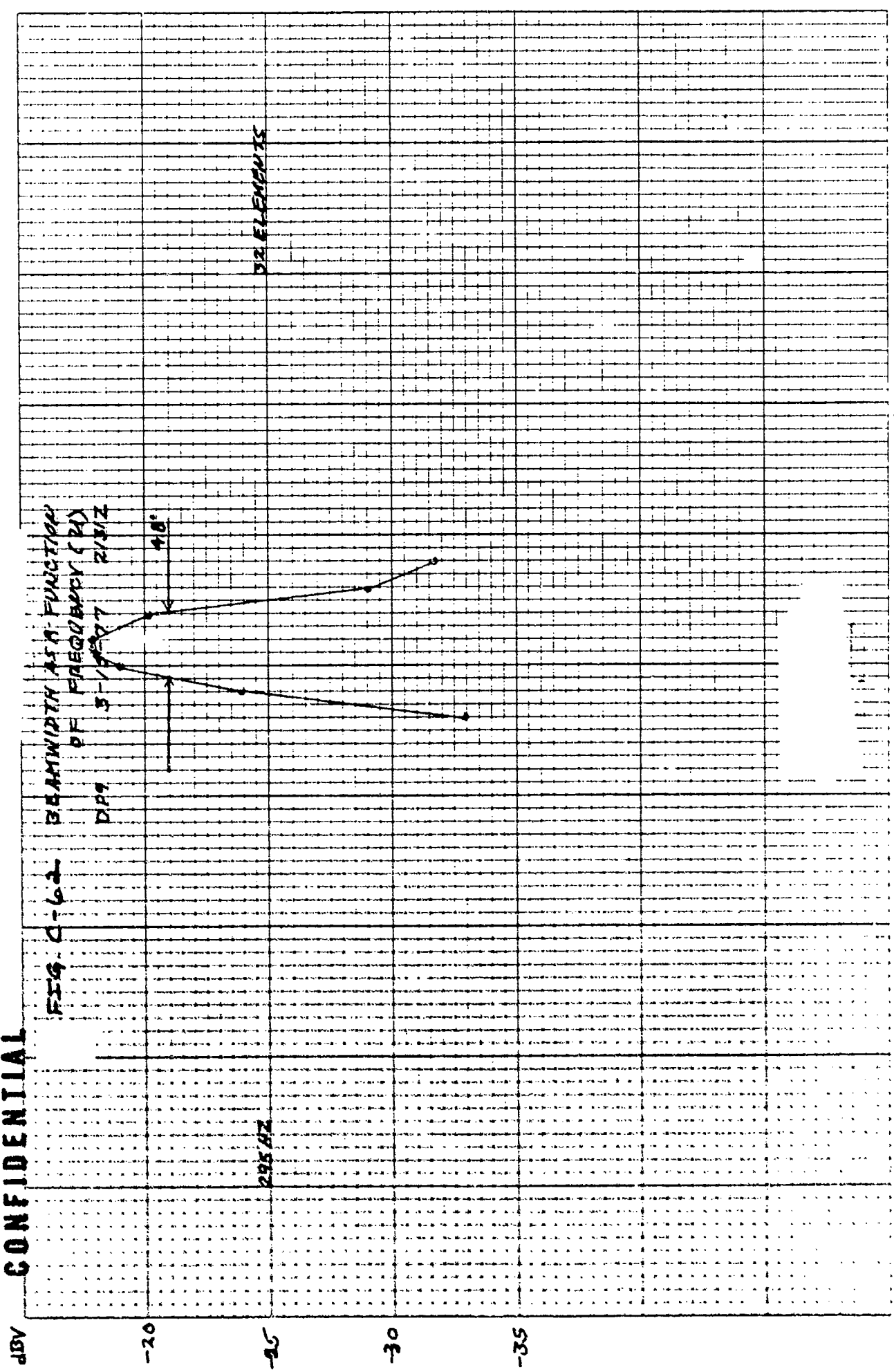


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 HEDFEL & BERRY CO. MADE IN U.S.A.

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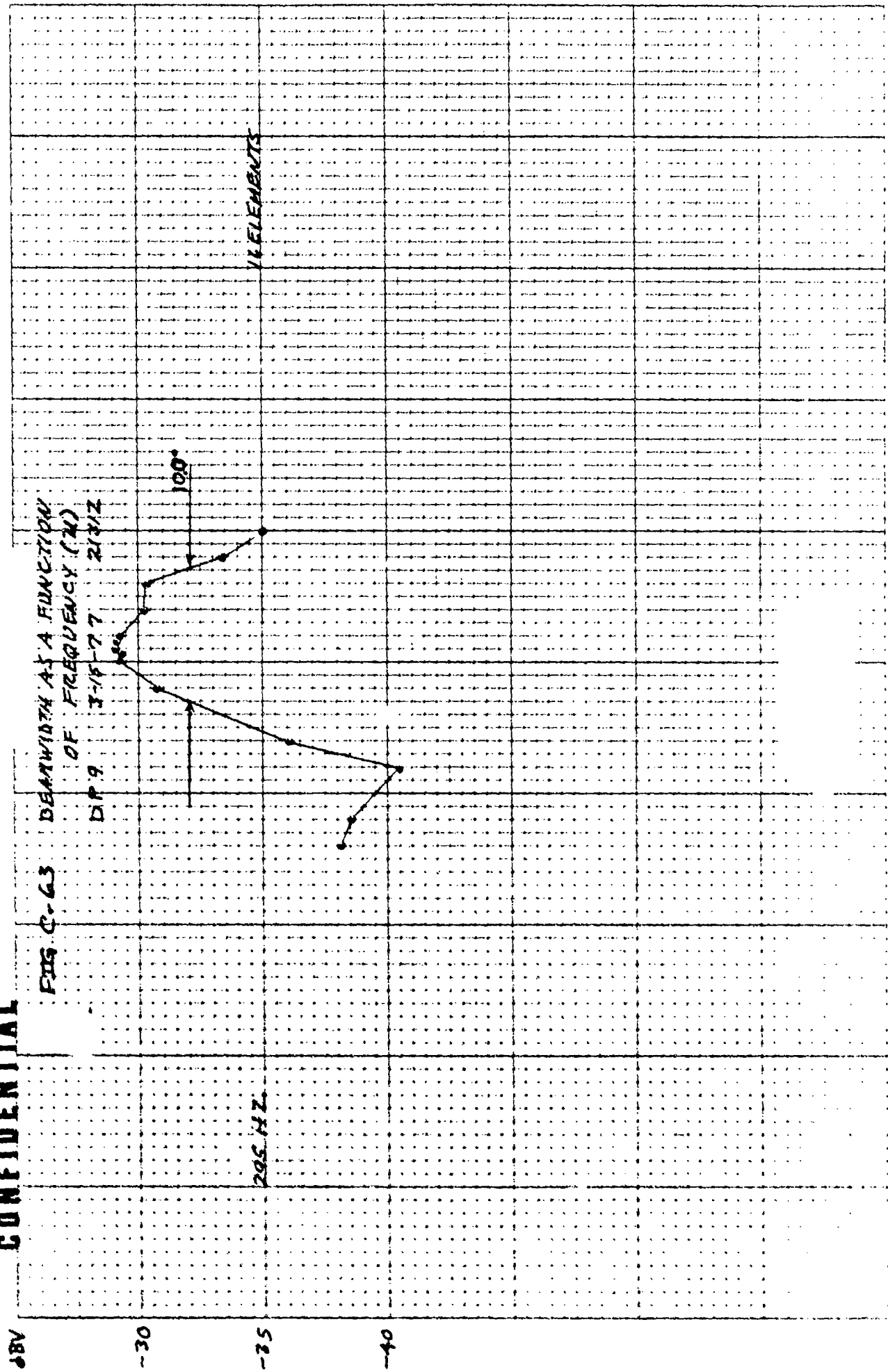


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10-2
10-1
10-0
9-9
9-8
9-7
9-6
9-5
9-4
9-3
9-2
9-1
9-0
8-9
8-8
8-7
8-6
8-5
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8-3
8-2
8-1
8-0
7-9
7-8
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7-6
7-5
7-4
7-3
7-2
7-1
7-0
6-9
6-8
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6-6
6-5
6-4
6-3
6-2
6-1
6-0
5-9
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5-4
5-3
5-2
5-1
5-0
4-9
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4-2
4-1
4-0
3-9
3-8
3-7
3-6
3-5
3-4
3-3
3-2
3-1
3-0
2-9
2-8
2-7
2-6
2-5
2-4
2-3
2-2
2-1
2-0
1-9
1-8
1-7
1-6
1-5
1-4
1-3
1-2
1-1
1-0
0-9
0-8
0-7
0-6
0-5
0-4
0-3
0-2
0-1
0-0

46 0/03



DEGREES OFF BROADSIDE

+30

+40

+50

+60

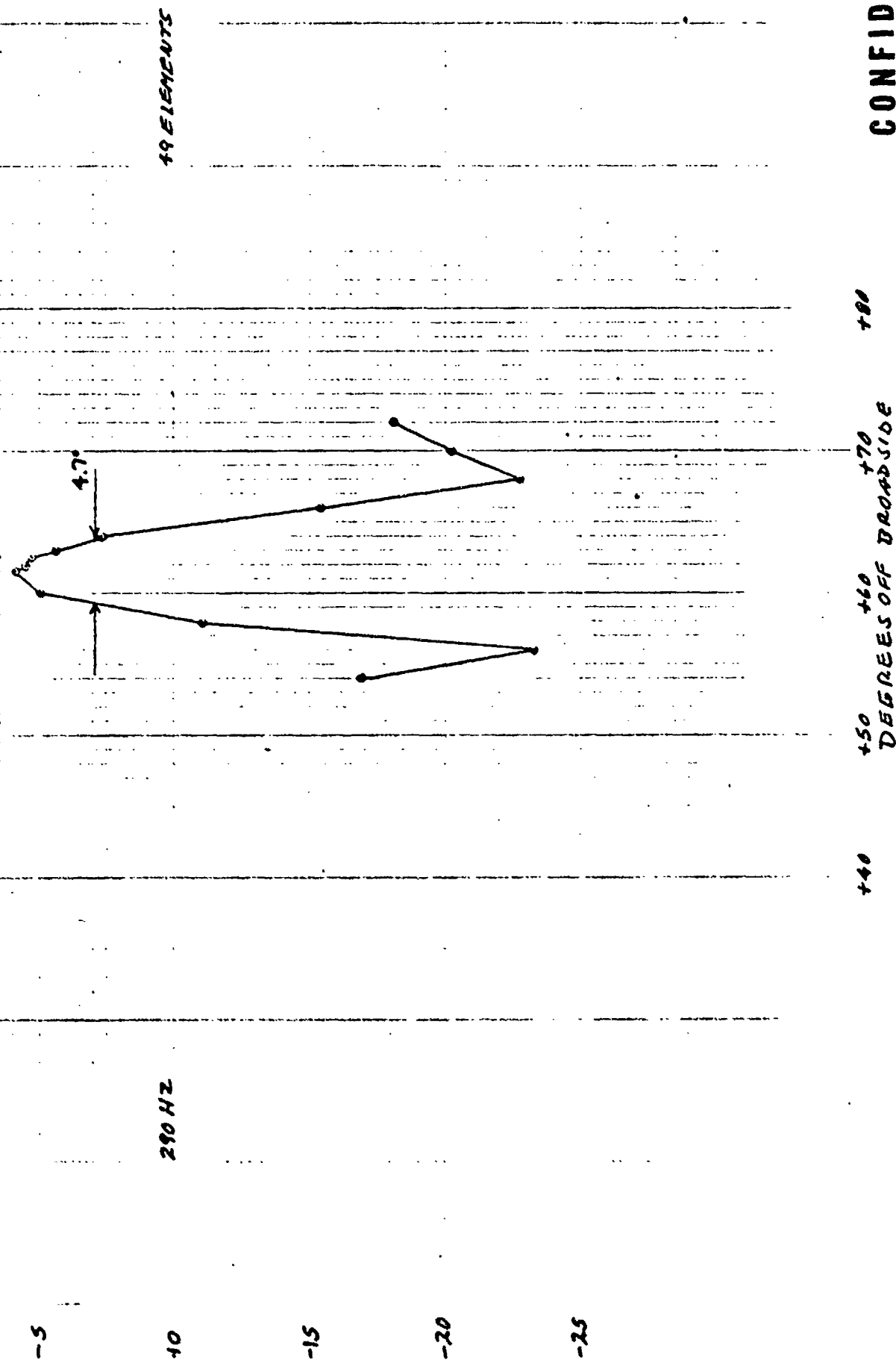
+70

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FIG. C-64 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DP10 3-16-77 0633Z



+50 +60 +70
DEGREES OFF BROADSIDE

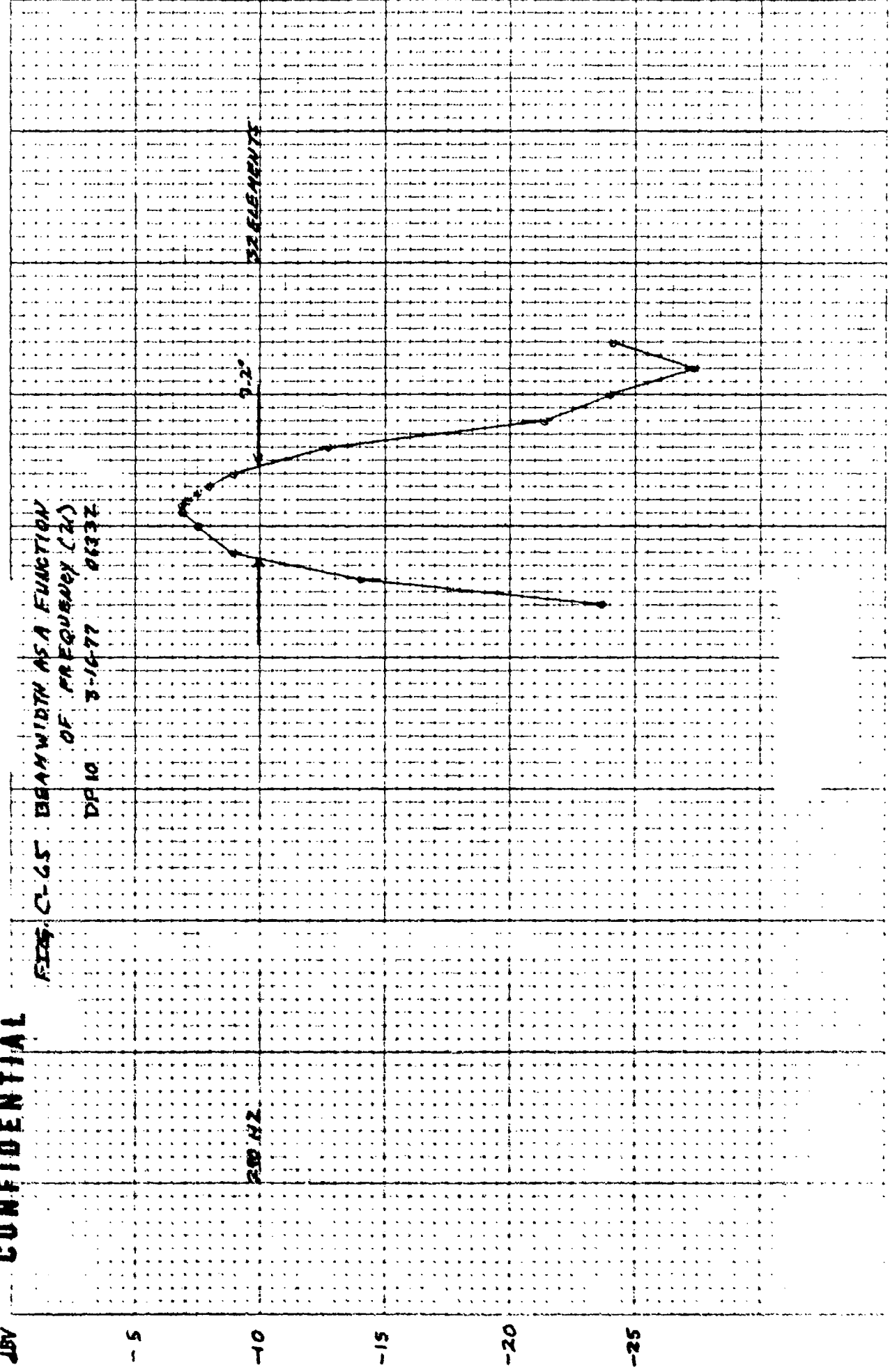
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FIG. C-65 BANDWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DP 10 3-10-77 0133Z



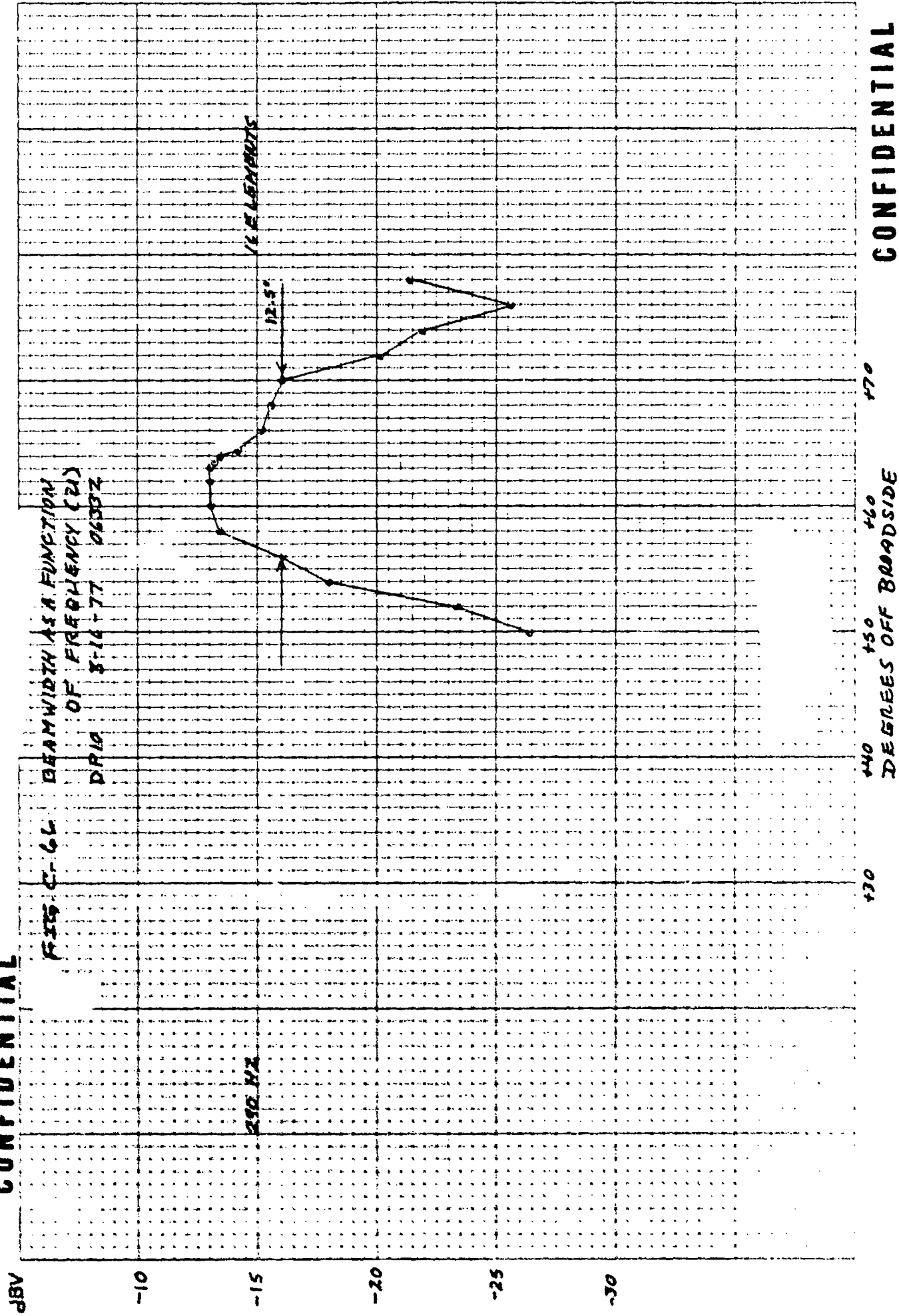
430 440 450 460 470
DEGREES OFF BROADSIDE

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10 A 10 TO THE INCHES
JESSIE BASSON CO. NEW YORK

46 0703

CONFIDENTIAL



CONFIDENTIAL

CONFIDENTIAL

18V

FIG. C-68

BEAMWIDTH AS A FUNCTION
 OF FREQUENCY (21)
 DR10 5-16-77 0630Z

+10

14-5

SEE ELEMENTS

14.5

0

-5

-10

+20

+40

+50

+60

+70

DEGREES OFF BROADSIDE

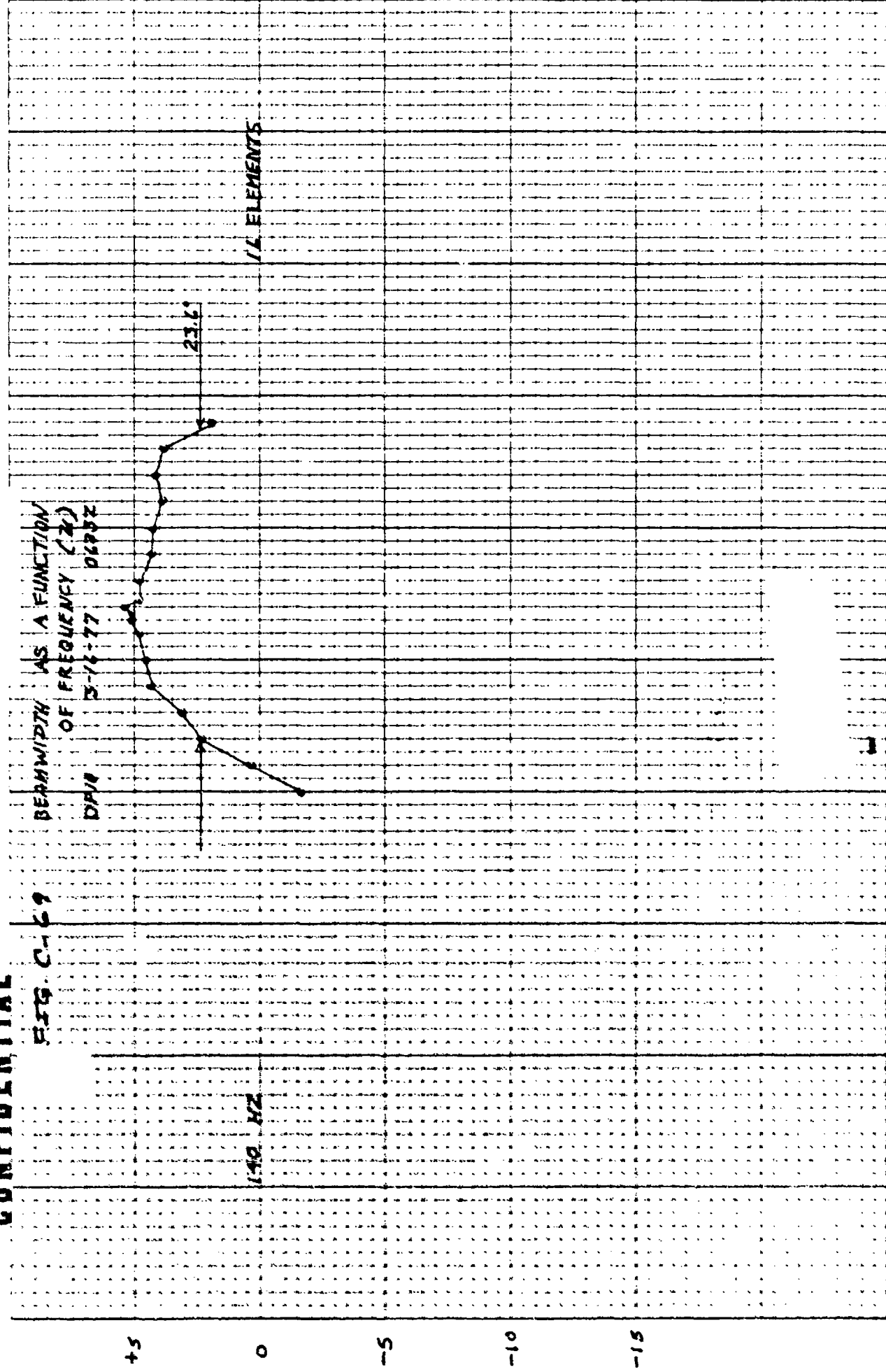
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FIG. C-69

BEAMWIDTH AS A FUNCTION
OF FREQUENCY (K)
DPA 3-16-77 062952



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+80

+70

+60

+50

+40

DEGREES OFF BROADSIDE

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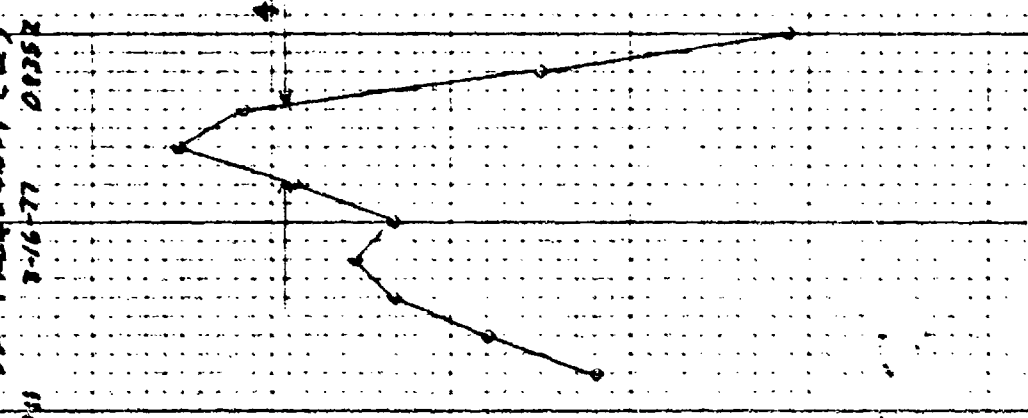
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BANDWIDTH ASA FUND T100
ON FREQUENCY (21)
DPH 7-16-77 0855Z

214062

○

5276413 15



+50 +60 +70
DEFENSES OFF BROADSIDE

80

024

100

450

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-35

FIG. C-71

BEAMWIDTH AS A FUNCTION
OF FREQUENCY (21)
DP II 3-16-77 0035Z

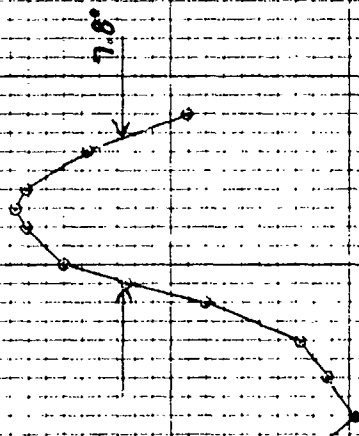
-40

290HZ

32 ELEMENTS

-45

-50



+80

DEGREES OFF BROADSIDE

+60

+70

+40

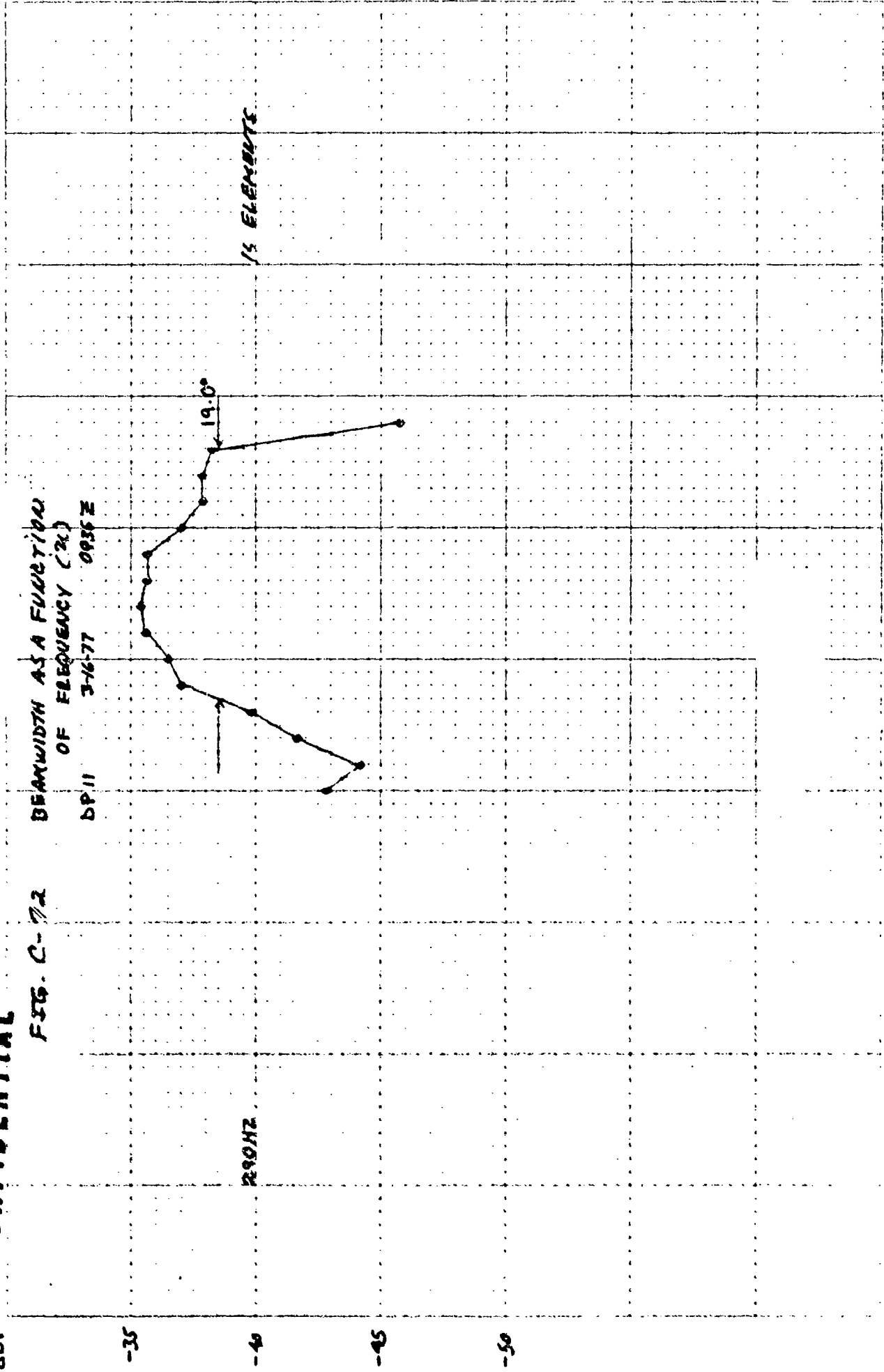
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FIG. C-72

BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)

DP11 3-16-77 0935Z



46 U/03

190

+80

+70

+60

+50

+40

+30

+20

+10

0

DEGREES OFF BROADSIDE

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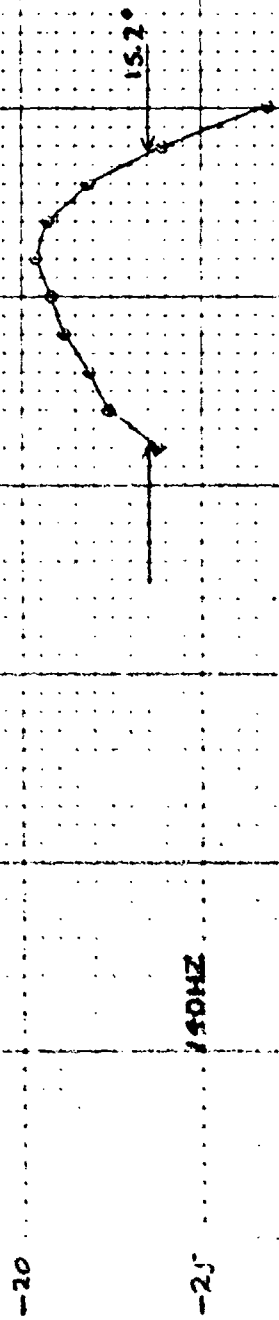
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FIG. Q-73 BEAMWIDTH AS A FUNCTION OF FREQUENCY (24)

DPH 3-16-77 0935Z



150HZ

51 ELEMENTS

40

50

60

70

80

DEGREES OFF BROADSIDE

CONFIDENTIAL

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CHD
AOL
34

CONFIDENTIAL

13P

FIG. 6-74
BEAMWIDTH AS A FUNCTION
OF FREQUENCY (20)
DPU 346-77 09352

五

15042

547537325

084

07+

110 070 +76°
2.8 GREENS OFF BROADSIDE

三

100

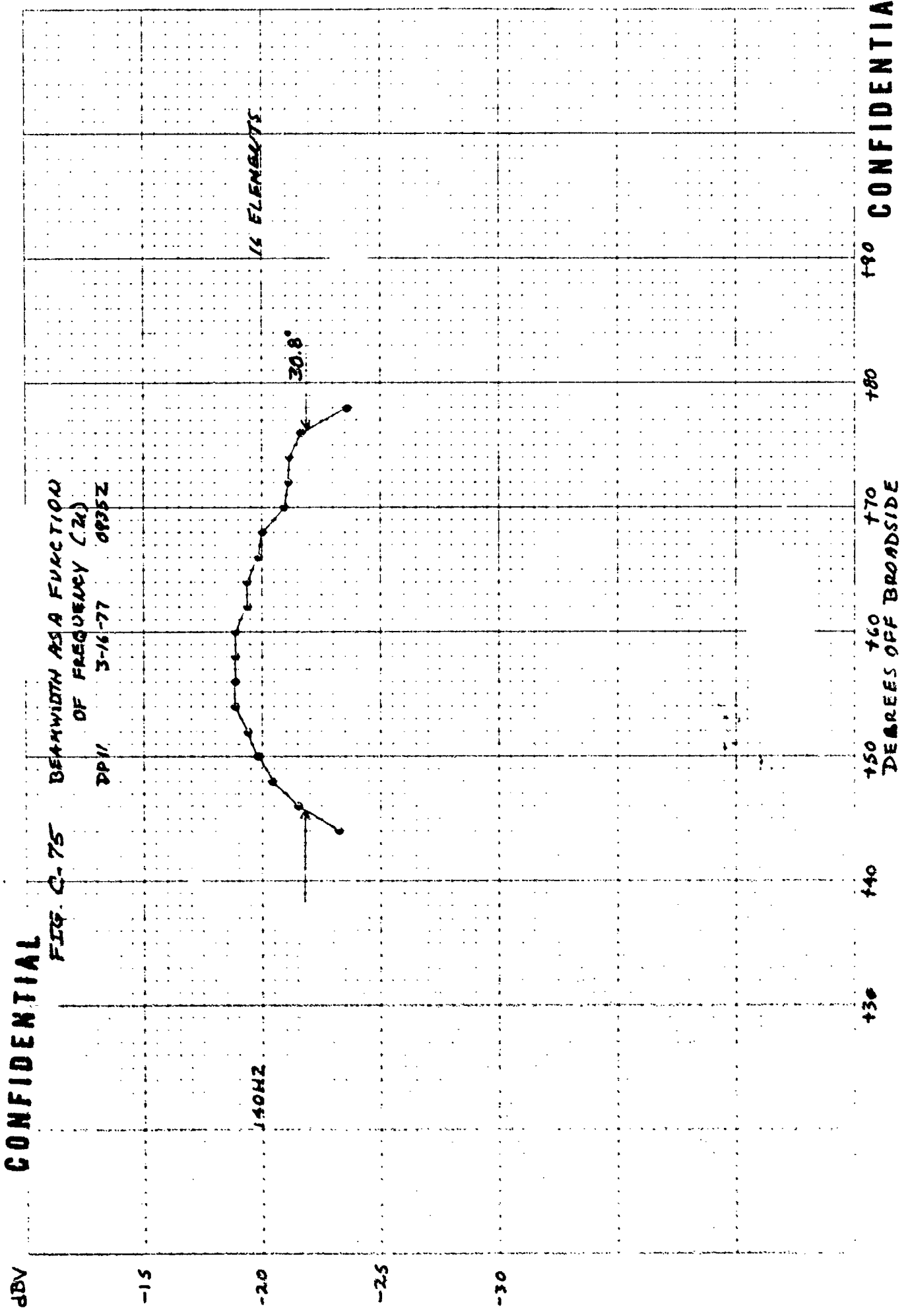
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FIG. C-75 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DPII 3-16-77 0935Z



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DP13

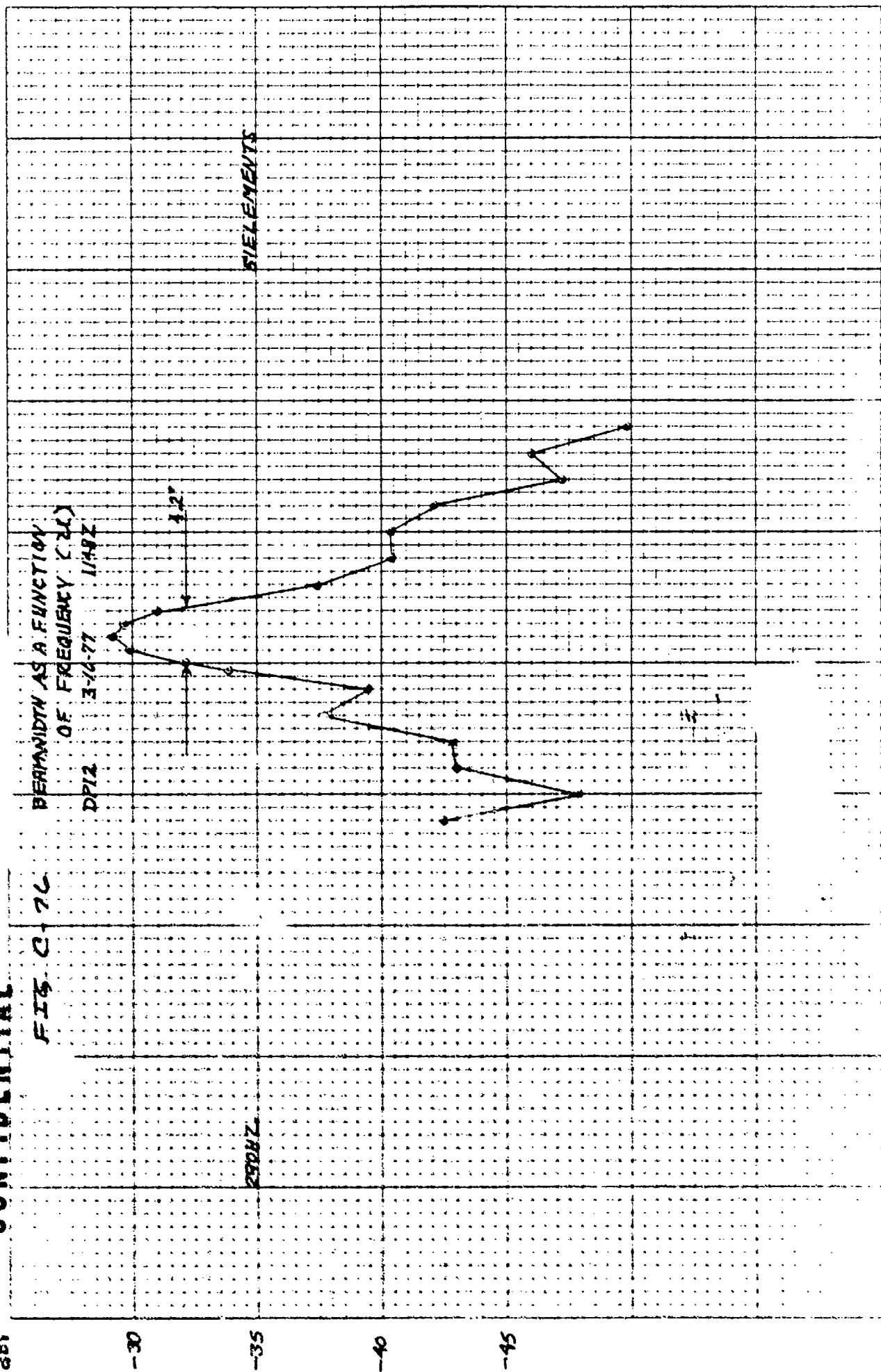
3-16-77

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12

280622

SLN637315



DEGREES OFF BROADSIDE

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...

+70°

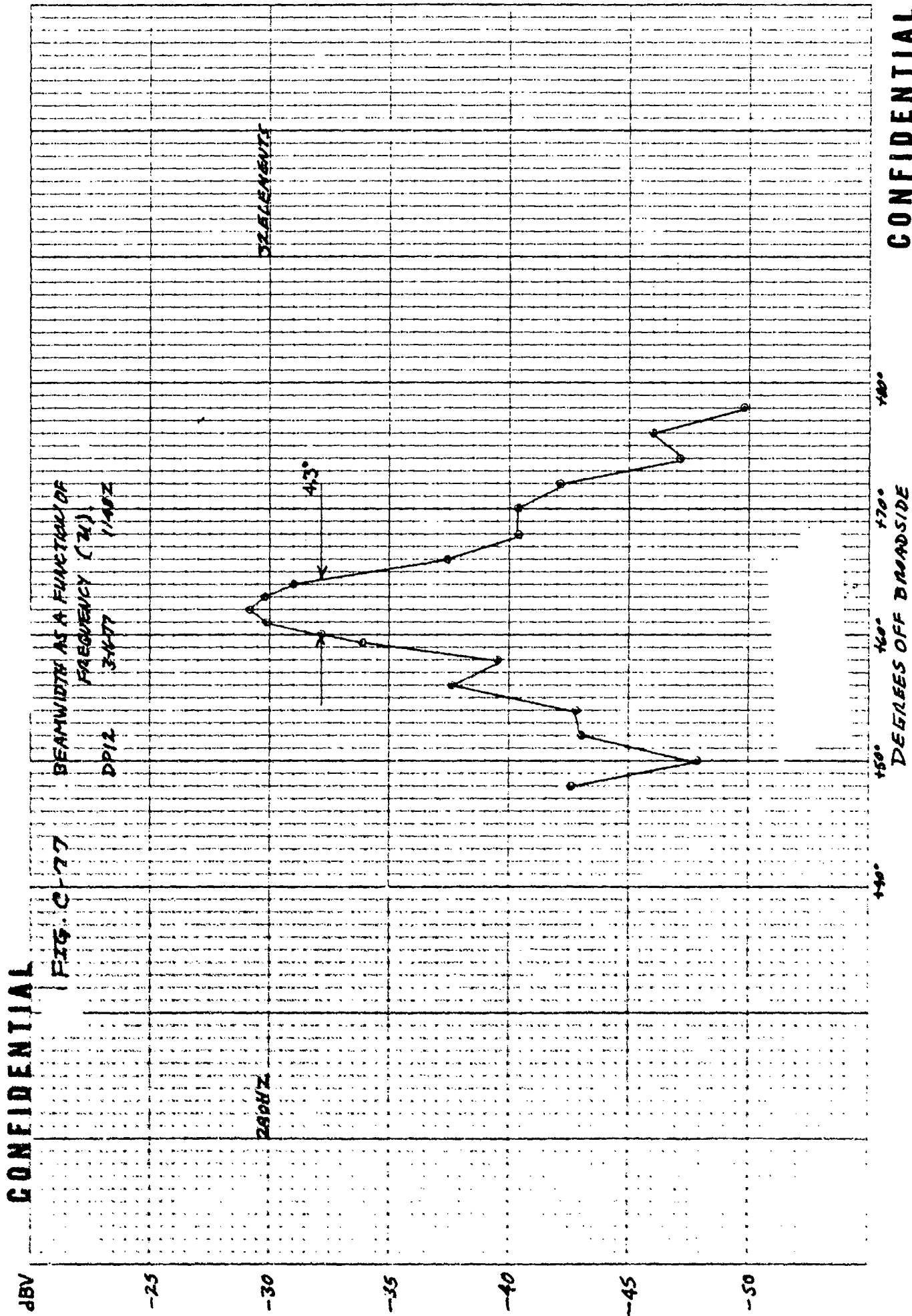
1087

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CONFIDENTIAL

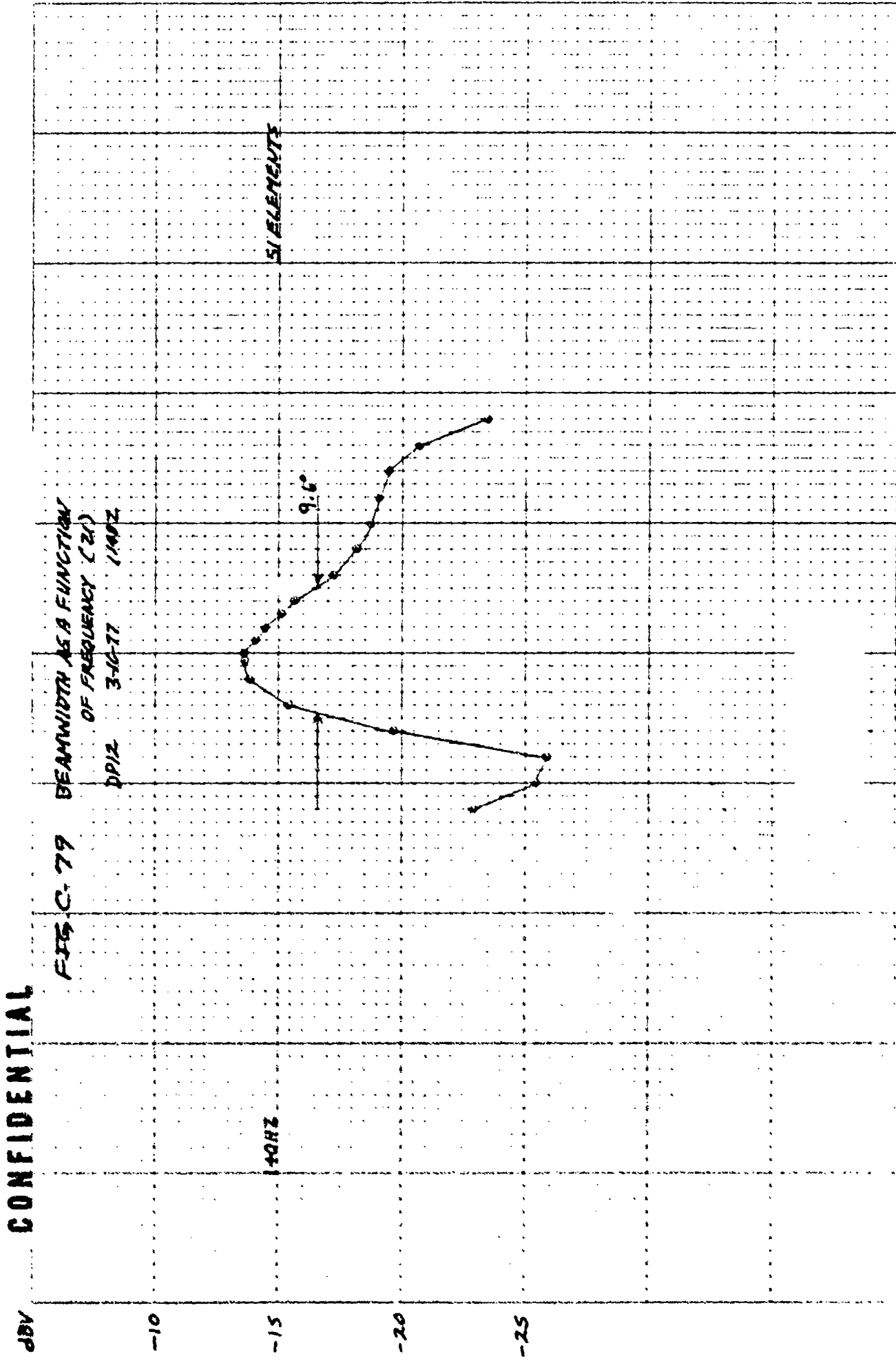
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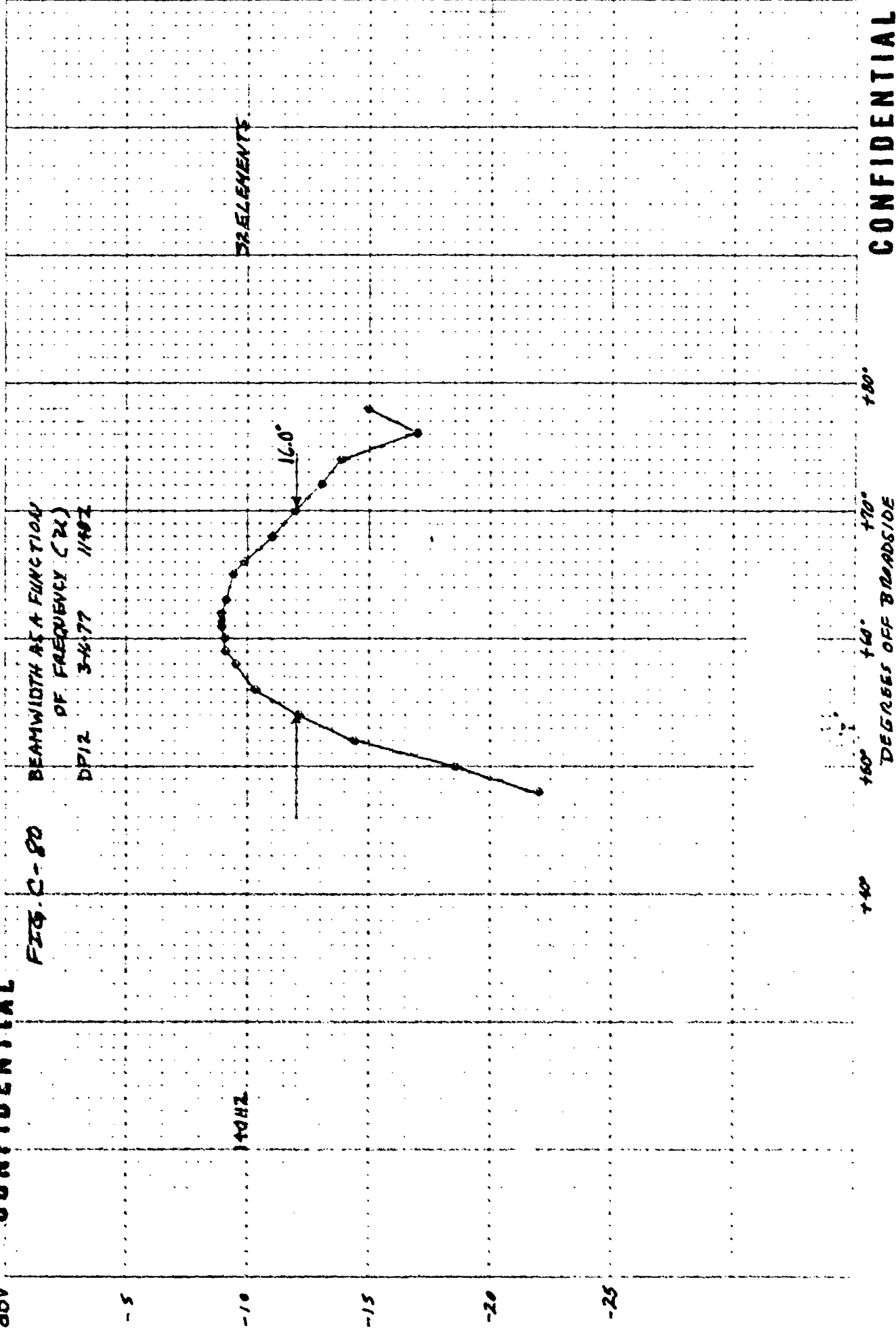
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FIG. C-80 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)

DP12 34677 11802



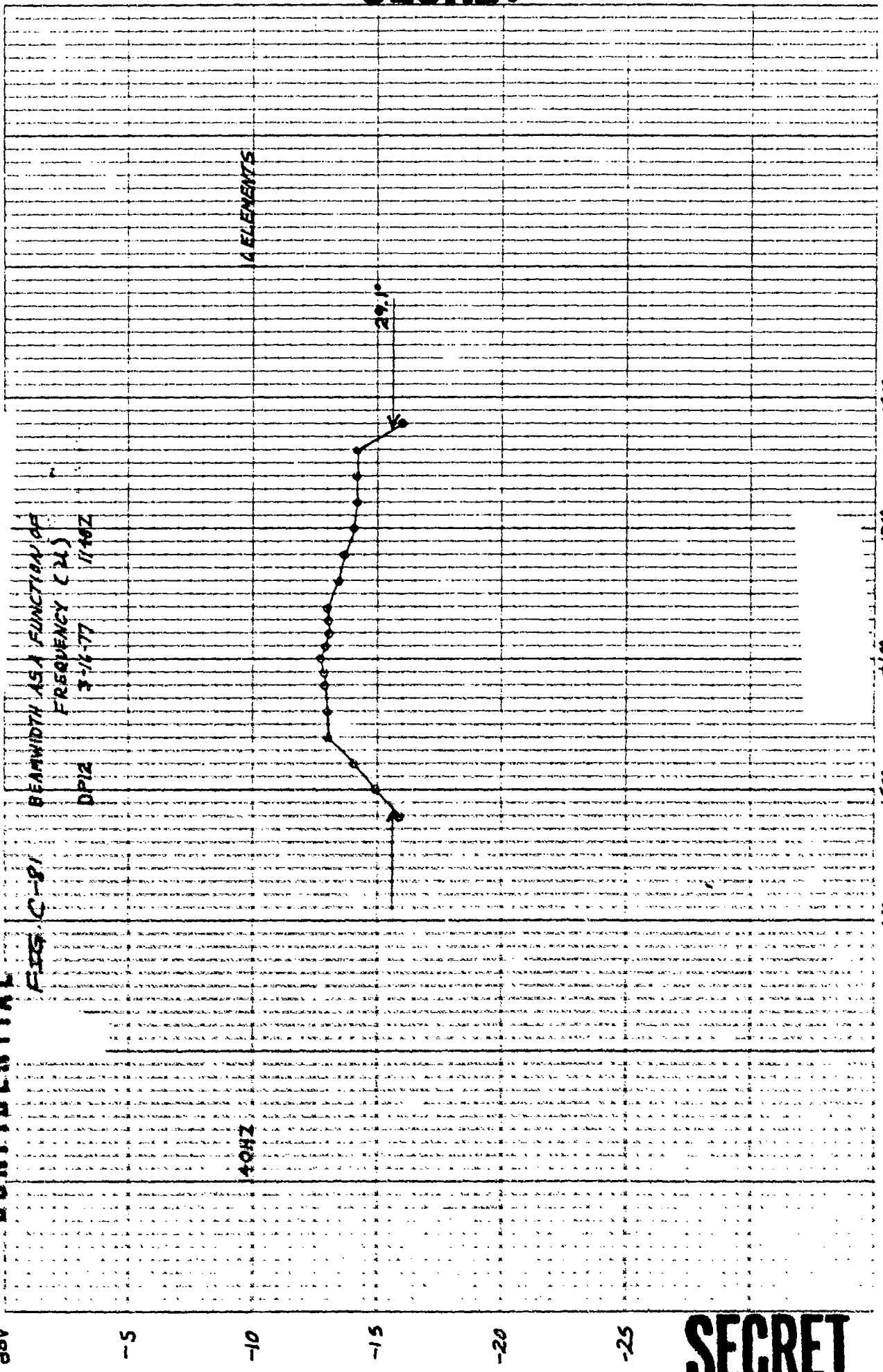
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OFFICE OF NAVAL RESEARCH
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IN REPLY REFER TO:

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MEMORANDUM FOR DISTRIBUTION LIST

Subj: DECLASSIFICATION OF LONG RANGE ACOUSTIC PROPAGATION PROJECT (LRAPP) DOCUMENTS

Ref: (a) SECNAVINST 5510.36

Encl: (1) List of DECLASSIFIED LRAPP Documents

1. In accordance with reference (a), a declassification review has been conducted on a number of classified LRAPP documents.
2. The LRAPP documents listed in enclosure (1) have been downgraded to UNCLASSIFIED and have been approved for public release. These documents should be remarked as follows:

Classification changed to UNCLASSIFIED by authority of the Chief of Naval Operations (N772) letter N772A/6U875630, 20 January 2006.

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3. Questions may be directed to the undersigned on (703) 696-4619, DSN 426-4619.

A handwritten signature in black ink, appearing to read "B. F. Link", is positioned above the typed name.

BRIAN LINK
By direction

Subj: DECLASSIFICATION OF LONG RANGE ACOUSTIC PROPAGATION PROJECT
(LRAPP) DOCUMENTS

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Declassified LRAPP Documents

Report Number	Personal Author	Title	Publication Source (Originator)	Pub. Date	Current Availability	Class.
Unavailable	Bossard, David C.	ACOUSTIC ANALYSIS/ASEPS	Wagner Associates	780726	ADA076268	U
NRLMR3832	Heitmeyer, R., et al.	PRELIMINARY RESULTS OF AN ANALYSIS OF BEAM NOISE IN THE MEDITERRANEAN (U)	Naval Research Laboratory	780901	ADC ND 016 220	U
Unavailable	Watrous, B. A.	PARKA I OCEANOGRAPHIC DATA COMPENDIUM	Naval Ocean R&D Activity	781101	ADB115967	U
Unavailable	Dunbar, B., et al.	LAMBDA PROCESSING LABORATORY AND ENGINEERING SUPPORT, FINAL REPORT 1 JANUARY 1977 - 31 OCTOBER 1978	Texas Instruments, Inc.	781129	ND	U
Unavailable	Blumen, L. S., et al.	ASTRAL MODEL. VOLUME 2: SOFTWARE IMPLEMENTATION	Science Applications, Inc.	790101	ADA956122	U
Unavailable	Spofford, C. W.	ASTRAL MODEL. VOLUME 1: TECHNICAL DESCRIPTION	Science Applications, Inc.	790101	ADA956124	U
Unavailable	Townsend, R., et al.	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME IA. OVERALL PROGRAM PERFORMANCE RESULTS WITH TEST RESULTS SUMMARY	Sanders Associates, Inc.	790101	ADC017573	U
Unavailable	Unavailable	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME IB. DETAILED DESCRIPTION, TEST RESULTS	Sanders Associates, Inc.	790101	ADC017574	U
Unavailable	Unavailable	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME II. DATA ANALYSIS FACILITY AND DATA REDUCTION METHODOLOGY	Sanders Associates, Inc.	790109	ADC017575	U
Unavailable	Unavailable	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME IIIA. DATA POINTS 1, 2 AND 3 RAW DATA	Sanders Associates, Inc.	790109	ADC017576	U
Unavailable	Unavailable	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME IIIB. DATA POINTS 4, 5 AND 6 RAW DATA	Sanders Associates, Inc.	790109	ADC017577	U
Unavailable	Unavailable	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME IVA. DATA POINTS 7, 8 AND 9 RAW DATA	Sanders Associates, Inc.	790109	ADC017578	U